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THE AMERICAN JOURNAL OF ROENTGENOLOGY
RADIUM THERAPY AND NUCLEAR MEDICINE

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ROENTGEN INTERPRETATION OF VESICULOGRAMS

By PROFESSOR ATHAYDE PEREIRA
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THE problem of the roentgen demonstration of the seminal vesicles which seemed to be completely cleared up took on new interest after the announcement of Lichtenberg's conception of the pathology of the system.

Urography showed that sometimes the cause of certain diseases of the excretory tracts of the kidney (lithiasis, pyelitis, pyelonephritis, pyonephroses, chiefly secondary) was the existence of an inflammatory disease of the male adnexa.

The relations of the ampulla of the vas deferens as well as of the seminal vesicles (Moellendorf's vesicular gland) to the pelvic part of the ureter explain this fact.

The inflammatory infiltration may reach this part of the ureter and cause the obstruction responsible for the stagnation of urine with all its immediate and late consequences (dynamic disturbances, infection, lithiasis, etc.).

Up to that time the roentgen demonstration of the seminal vesicles and the spermatic tract had not awakened any other interest than the study of their anatomical variations and their relation to the diseases peculiar to them. Also, because of the difficulty of its execution and the small amount of information which it gave, its indications were extremely limited.

However, with simplification of operative methods and the progress of scientific industry, providing apparatus which could be used effectively, the routes of access to the seminal vesicles were opened up to roentgen exploration.

And, finally, the conception of the pathology of the system enlarged its indications.

The idea of the roentgen demonstration of the seminal vesicles and the spermatic tracts was intimately related to the question of the treatment of their chronic inflammatory diseases as the routes of access for this purpose which appeared when contrast media for roentgen examination were acquired made it possible for them to be revealed roentgenographically.

Young (1913) made the first injection of contrast medium into the seminal vesicles. He was followed by Luys who had a different object in view (treatment of vesiculitis). Both used the urethral route by catheterization of the ejaculatory canals which had long since (1895) been tried by Herman Klotz and Wassiljeff, these authors using urethroscopy by direct vision and metallic or elastic sounds.

Luys then became the pioneer in this

subject, perfecting not only the endoscopic instruments available, but also the technique of catheterization of the ejaculatory canals and the introduction of medicinal substances into the seminal vesicles (London Congress, 1913).

The subject was followed with interest by Waters, Le Fur, Pancoast, Picker, Kropheit, Barney, Delzell, and Lowsley, with regard not only to the question of the treatment of spermatocystitis by catheterization of the ejaculatory ducts but with reference to the question of roentgenography of the seminal vesicles.

In spite of this effort no very great advances were made in the method.

The difficulties of dry urethroscopy and the unforeseen incidents in inaccurate and even dangerous catheterization moderated the enthusiasm of these investigators.

Von Lichtenberg and McCarthy deserve credit for the creation of irrigation urethroscopy which permitted catheterization of the ejaculatory ducts with less trauma and greater exactitude.

Peterson of New York, taking as a basis the method of introducing the elastic sounds of McCarthy's apparatus, perfected dry urethroscopy to the point where it permitted of perfect catheterization with the same advantages as with the irrigation apparatus.

On the other hand, the experiments of Graff (injection of air, water, etc., into the vas deferens of cadavers) led Chevassu to try the injection of opaque substances through the vasa deferentia for purposes of roentgen examination. He used 5 per cent collargol, but found later that this substance was not sufficiently opaque.

Belfield in 1906 won priority in the treatment of the vesicles by medicinal injections through the vasa deferentia. He used the process called vasotomy and made injections into the vasa deferentia with metallic cannulas or fine sounds kept in permanently.

This method was then followed by Barney, Dillon and Blaisdell, Bungener and others.

Belfield substituted for vasectomy vasopuncture (called Luys' vasopuncture), and in 1913 performed the first roentgenography of the seminal vesicles (with a solution of collargol), in which he was immediately followed by Young and Waters, whose previous attempts were already known.

The method of Bungener-Belfield was then greatly popularized by Thomas, Rolnick, Cumming and Glenn, Luys, Simons, Delzell and Lowsley, Francois, Kidd, Wolbarst, Irwing, Herbst, Chauvin, Boeminghaus, Maraini, Heckenbach and others, with various modifications in operative technique.

In our country Belmiro Valverde became a pioneer in this question of roentgenography of the seminal vesicles through papers presented before the National Academy of Medicine and reviewed in numerous foreign medical periodicals; he used both the transurethral method with catheterization of the ejaculatory ducts and the vas deferens method of Bungener-Belfield.

He was followed by Estelita Lins, Brandão Filho, Brandino Correia, Athayde Pereira, Santamaria, Monteiro and others, some preferring the transurethral ejaculatory route and others the deferential (vasopuncture).

Later the question was studied by Santamaria who took the initiative among us in the development of the technique of catheterization of the ejaculatory ducts and vesiculography by the transurethral method.

The subject aroused the greatest interest in the medical circles of São Paulo and Rio de Janeiro, and heated discussions took place in the medical societies on the fundamental points in the interpretation of the roentgen images of the seminal vesicles, a great deal being contributed at this time to this extremely interesting subject by Belmiro Valverde, Estelita Lins, Athayde Pereira, Santamaria, Martins Costa, Jarbas de Barros, Geraldo de Azevedo, and Cristiniano de Sousa.

The discussions at this time (1934 and

1935) were chiefly on the interpretation of the images obtained by Santamaria in vesiculograms taken by way of the ejaculatory tract, which were interpreted as being due to a diffusion of contrast medium through the walls of the seminal vesicles and an indication of an inflamed condition of the same.

The opposing idea initiated by us (Athayde Pereira), with the collaboration later of Belmiro Valverde and Martins Costa, deserves credit for giving the correct interpretation to those images, considering them due to extravasation or diffusion of the contrast medium through lesions of the ejaculatory ducts or fissuring of the vesicles from hyperpressure.

Then at the second Brazilian Congress of Urology (Rio de Janeiro, 1940), Santamaria insisted on his way of interpreting his images as well as his way of obtaining them, that is by the injection of contrast medium through the vas deferens.

At this time the exact knowledge of the mechanism of reflux and extravasation no longer left us and other specialists in any doubt as to the interpretation of Santamaria's images, called "hair nets of hairs of absorption." They were therefore considered vesicular extravasations from fissuring and caused by excess of pressure on injecting the contrast medium.

In order to comprehend better the fundamental points which govern the interpretation of contrast roentgenograms of the seminal vesicles and spermatic tract, it is well to have in mind some anatomical and histological data on the subject.

So far as roentgen interest is concerned we have to consider only the vasa deferentia from the funicular to the abdominopelvic portion, including the dilated retrovesical ampullar part (Henle) and, finally, the seminal vesicles (Moellendorf's vesicular gland.) The former, cords 40 to 45 cm. in length and 2 to 3 mm. thick, present a narrow lumen of not more than 0.16 mm., a section of which has a stellate appearance because of the five to seven mucous folds which occupy it. From its beginning at the tail of the epididymis to the inguinal canal, accompanying the different elements of the cord, it constitutes the ascending part. The descending part develops in the abdominal cavity to its dilated part. At 4 cm. above the prostate this dilatation constitutes the ampulla, or "glandular part" of Vesalius. Three to four centimeters in length by 0.4 to 1.0 cm. in breadth (Waldeyer) it lies close to the bladder wall (trigonal region) and passes toward the prostate in the form of a narrow canal, the ejaculatory duct.

By the separation of the two a triangular space is formed called the interampullar trigone. Its histological structure is represented by: a mucosa in folds and cylindrical epithelium with a secretory function (Shaeffer), a delicate smooth musculature, longitudinal and circular, and an adventitia that also has circular and longitudinal elements. In the part where the ejaculatory ducts begin the two excretory ducts of the seminal vesicles empty. These are two similar hollow organs,* flattened in the dorsoventral direction, in contact with the bladder in front and above with the prostate below and the wall of the rectum behind and below.

They are located in a pocket of loose cellular tissue and fixed by Tirrel-Denonvillier's fold of the prostatoperitoneal aponeurosis, which is attached on the one side to the base of the prostate and on the other to its posterior surface. This fold creates a triangular pocket with its base upward in which are found the ampullae and the seminal vesicles.

According to Sappey, this aponeurosis is formed of elastic tissue and of smooth muscle fibers, some of them transverse and some longitudinal, described by Henle, and which unite with the muscle fibers of the rectum. They aid in the emptying of the vesicles and ampullae and for this reason are called expulsor muscles (Testut) or compressor muscles of the seminal vesicles and seminal duct (Vinner-Ellis).

* Long tubes folded on themselves, presenting a series of prolongations into a blind pouch.

There are three parts to the vesicles: the base, the neck and the intermediate part. Their size varies with age, with the degree of filling, and, particularly in cases of inflammatory disease, with the stage of its evolution.

The right vesicle is frequently the larger. The measurements vary in accordance with the types of their anatomical variations. The average, in nine-tenths of the cases (Guelliot), is 45 to 55 mm. in length, 15 to 20 mm. or more in breadth (Henle) and about 10 mm. in thickness.

Their capacity varies, and this is of special interest in the question of roentgen filling. In general, it is from 1.5 to 2.5 cc. (Guelliot). In cadavers Picker found variations of from 5 to 11 cc.

The contents is a secretion, sometimes liquid, sometimes mucous, and sometimes similar to pus in appearance with typical moulds and rounded concretions, called by Robin "sympexions."

The ampulla, as is known, is a reservoir in which the products of secretion which are to make up the semen accumulate.

The ejaculatory ducts, the terminal part of the vasa deferentia, penetrate into the interstices of the prostate and empty into the colliculus seminalis (verumontanum), sometimes on the sides, sometimes on the anterior surface, sometimes posteriorly and also sometimes into the Müllerian duct or prostatic utricle, through a fissure or orifice of varying size. About 20 to 25 mm. in length by 0.5 mm. in thickness, it sometimes presents a dilatation called the "ejaculatory sinus." Here, too, sometimes in catheterization the wall is perforated and tissue fluids and blood may flow in during the injection of the contrast medium.

One of the characteristics which should not be forgotten in the anatomy of the seminal vesicles is their variability in shape and appearance.

The anatomical varieties are called those of Pallin, Perna and Picker, because they were described by them. Pallin, by means of injections of celloidin, a corrosive preparation, divided the vesicles into the following types, depending on the direction of the main canal and the number of its diverticula.

I. Vesicles with a main canal not very tortuous:

(a) with short branches equally developed;

(b) with branches irregularly developed and very branching and tortuous.

II. Vesicles with the main canal very tortuous:

(a) with equal diverticula;

(b) with branches very ramifying and tortuous.

Perna proposes a classification based on embryology and comparative anatomy, distinguishing four fundamental types:

I. Vesicles made up of a body or ascending part, continuing into a descending or reflex part, having one or two diverticula at the base.

II. Vesicles made up of only an ascending part with one or two basal diverticula.

III. Vesicles made up of an ascending part without a descending part and with basal diverticula.

IV. Vesicles made up of only an ascending part without a descending part and without basal diverticula.

Picker, more recently, classifies the vesicles according to the roentgen images obtained by the injection of collargol or Beck's paste.

He gives six fundamental types:

I. Vesicles with a short, straight main canal.

II. Vesicles with the main canal large and tortuous, with or without diverticula.

III. Vesicles with the main canal narrow but long and tortuous, without diverticula or with diverticula not very highly developed.

IV. Vesicles with a very highly developed main canal, straight or tortuous but with large diverticula arranged like bunches of grapes.

V. Vesicles with the main canal short but provided with large branching diverticula.

VI. Congenital anomalies.

All of this deserves the most careful attention when it comes to interpreting the roentgen images of the seminal vesicles and spermatic ducts.

With regard to possible lesions of the seminal vesicles and spermatic tracts during catheterization of the ejaculatory ducts, it should be remembered that these organs are very vascular and therefore under such circumstances their veins and arteries may be compressed, making embolism possible, if the catheterization is followed by medicinal injections or oily contrast media.

On reviewing the anatomy and histotopography of these organs we see how and by what processes they may be demonstrated roentgenographically.

First of all, it is evident that only the lumen will be shown, with the anatomical variations described above, but that in pathological cases the image will be in accordance with the changes produced by lesions of the organ or the neighboring tissues. These vary from lack of filling to scanty, normal, or even excessive filling when there is dilatation of the cavities (dynamic disturbances).

Such roentgen investigations in general show congenital anomalies, defects acquired from the diseases peculiar to these organs, or caused by affections of neighboring organs (tumors of the prostate, bladder or rectum), and especially in cases of chronic inflammation, by showing variations in the form of the lumen they give a reasonable understanding of methods of treatment and their possible success. For this purpose, the vesicles are filled with contrast medium by one of the two ways most accepted in practice: the ejaculatory route (transurethral) and the deferential route (vasopuncture). Though they have for the most part been abandoned, the transrectal puncture of Tailor, the perineal and Lespinasse's transcutaneous vasopuncture are sometimes done.

The following objections have been made to the first method: (*a*) its direct dependence on the permeability of the urethra; (b) variability in the anatomical site of the openings of the ejaculatory ducts and the existence of lesions of the colliculus (verumontanum) which may obstruct them or render them invisible; (c) the possibility that there may be false routes capable of causing an influx of the substance injected into the veins and arteries.

The following arguments are used against the second method: (*a*) The necessity for a surgical operation which cannot be repeated; (*b*) the possibility that there may be obliteration of the vasa deferentia; (*c*) the possibility of their being obstructed by surgical trauma.

Nevertheless, it is certain that in daily practice, thanks to the perfection of endoscopic instruments and the simplification of operation, these two methods aid a great deal in the roentgen demonstration of the seminal vesicles, giving information which the modern pathology of the adnexal diseases of the urinary tract requires and enabling us to make use of the one or the other, depending on the possibilities in each particular case.

The Ejaculatory Route (*Transurethral*). The method of injection into the vesicles by catheterization of the ejaculatory ducts was, until recently, used less frequently because of a series of unforeseen occurrences brought about by dry urethroscopy and its metallic sounds with pointed ends. But scientific manufacture has now provided us with material that is so easily managed that most of these unforeseen difficulties have been overcome. This has resulted in its becoming a teaching method in constant use.

It depends entirely on whether posterior urethroscopy can be carried out (permeability of the urethra), and on the condition of the colliculus (verumontanum), which may or may not permit of the orifices being visible. Anomalies and variability in the location of the latter often make it impracticable.

The technique requires dry urethroscopy with the instrument of direct vision of the Peterson system, or irrigation urethros-

copy with the instruments of von Lichtenberg and McCarthy.

The system of dry urethroscopy with the apparatus of Luys, Demonchy and others, formerly used by some specialists, no longer meets the requirements of modern technique.

Catheterization becomes difficult and uncertain when traumatism occurs, making the urethra bleed, and the suffering of the patient forces the progressively accumulating contents of the vesicles to invade the field of observation, interfering with visibility and necessitating repeated aspiration. This greatly retards the maneuver of true catheterization.

In this system metallic sounds are used which are very sharply pointed so that on attempting catheterization of the ejaculatory ducts the technician, even if he is skillful, must take care to avoid driving the sound into the colliculus if he is not absolutely certain of having penetrated the ejaculatory ducts. Local traumatisms caused by these sounds are quite well known.

In the system which uses Peterson's instrument, the catheterization is performed with fine elastic sounds introduced as with McCarthy's instrument.

In irrigation urethroscopy, which is preferable, the operation is less traumatizing and better tolerated, as the catheterization is more accurate and better controlled, because of the clear visibility of the colliculus (verumontanum) and of the ejaculatory ducts.

In this method fine elastic sounds are used which are less capable of causing trauma; nevertheless the same care should be observed, as perforation may occur in the course of the duct (Athayde Pereira).

Thus catheterization depends on variability in the anatomical site of the ejaculatory ducts and on lesions of the colliculus which prevent their visibility or obstruct their openings.

Urethroscopy with any of the instruments referred to requires previous preparation of the patient, including dilatation of the urethra, if it is not permeable to the caliber of the urethroscope, treatment of the colliculus by the method of Belfield and others (painting with carbolic acid or a solution of silver nitrate), or even its destruction by curettage according to Franceschi's method and, finally, treatment of the intolerant neck (hypertonia of the sphincter).

In order to appreciate this difficulty fully, we may recall in passing that Subotzky in 33 cases, using irrigation urethroscopy (von Lichtenberg's apparatus) and epidural anesthesia, succeeded in performing catheterization and vesiculography in only 8 cases.

This same author (*Ztschr. f. Urol.*, 1930, *24*, 250–260) among 39 posterior urethroscopies observed:

in 15 cases the openings of the ejaculatory ducts were not visible;
in 10 cases they were not clearly visible;
in 9 cases they were visible on only one side;
in 4 cases both openings were distinctly visible.

We ourselves in 1935 published statistics of 21 cases which showed:

in 7 cases the ejaculatory ducts were invisible on account of colliculitis;
in 5 they were both perfectly visible;
in 2 they were visible on only one side;
in 3 catheterization was impossible because of atrophy of the colliculus and invisibility of the openings;
in 2 the ejaculatory ducts were obstructed and cystic on only one side;
in 1 the ejaculatory ducts were obstructed and cystic on both sides;
in 1 case the ejaculatory ducts opened into the prostatic utricle.

Nevertheless authors such as Sidney Ritter and Santamaria, the former using McCarthy's instrument and the latter that of Demonchy, catheterize the ejaculatory ducts very frequently as can be seen from their published works.

But lately Peterson has shown great enthusiasm for the ejaculatory route (urethroscopy proper) for the radical treatment of chronic adnexitis.

It should be noted that catheterization is frequently followed by perforation of the duct somewhere in its course, allowing injection of contrast medium into the cellular space of the pocket occupied by the vesicles and ampullae.

This results in the extravasations and diffusions, the venous and arterial inflow, shown roentgenologically by Santamaria (1934) in numerous cases; a fact which was attributed, before these accidents were better understood, to a false interpretation of the roentgen images.

To avoid such perforations the fact must be taken into consideration that the course of the ducts through the colliculus is a curve with the concavity outward.

On the other hand, the injection of contrast medium is not under control, resulting in general in distention and overdistention of the organ, or even fissuring or rupture with extravasation and local diffusion, which may become infected (with abscess as a local reaction), readily shown by roentgenography, or in trauma of the epididymis with an acute inflammatory reaction (epididymitis), which can easily be demonstrated clinically.

The trauma resulting from delayed urethroscopy may cause acute prostatitis, orchiepididymitis, disturbances of bladder dynamics with vesicorenal reflux and attacks of ascending pyelonephritis, and even pelvic suppurations from infection through false routes caused by apparent catheterization.

The Deferential Route. In filling the vesicles by the deferential route only the Bungener-Belfield method is used. Here the injection of contrast medium is made into the lumen of the vas deferens which is exposed surgically. It is a simple and slight operation but requires care in the use of rigorous asepsis.

It is performed under anesthesia, preferably local (infiltration), supplemented sometimes by infiltration anesthesia of the cord at the root of the scrotum, or by rachianesthesia (microrachi), epidural, peridural or general anesthesia.

The operation was simplified by American authors (Belfield, Bungener, Thomas) by exposing the scrotal part of the vas deferens instead of using puncture or vasotomy. Luys, however, in his well known technique, exposed all the cord surgically and then isolated the vas deferens.

It is a very extensive operation which requires a long time but it is still used by young specialists coming from schools which have used this routine.

Among the most advanced specialists the simplified technique of Belfield-Bungener-Thomas has become established, with the modifications of Kid, Maraini, Athayde Pereira, Boeminghaus, which only occasionally requires hospitalization, is benign in its course, healing takes place rapidly and there are rarely local results which prevent its repetition within a short time.

Technique:

(*a*) shaving of the hair at the root of the scrotum and of the scrotum itself;

(*b*) local disinfection with an alcoholic solution of picric acid (or tincture of merthiolate Lilly) (1:1000). Never iodine!

(*c*) palpation of the scrotal portion of the cord, separation of the vas deferens and bringing it up to the level of the skin (both on the anterior and posterior surface of the scrotum);

(*d*) fixation of the deferens with a Backhaus forceps (a small ball of metal is fixed to the end of this forceps to prevent pain to the patient when local anesthesia is used, as this stage precedes the infiltration of the anesthetic.

Maraini fixes it with a transcutaneous silk suture.

We maintain this fixation for a long time; then the anesthetic is infiltrated.

(*e*) local infiltration of the anesthetic, supplemented sometimes by infiltration of the cord at the root of the scrotum;

(*f*) short incision of the skin (2 to 3 cm.), then after slight traction with the forceps or a silk thread, incision of the fibrous covering and exposing of the vas deferens;

(*g*) isolation of a short length of the deferens and its fixation with a chaput forceps without injuring it;

(*h*) puncture of the lumen of the deferens, using a needle with a short bevel, taking care to make traction on the deferens in order to

better introduce the needle into its lumen, and make only one puncture. Multiple punctures cause trauma and often prevent injection at the same site by the extravasation of contrast medium. Needles of various calibers should always be available. This stage is the most delicate and therefore deserves the greatest care. If the needle pierces the opposite wall it results in the injection of the contrast medium beyond the deferens into the tissues of the cord.

(*i*) injection of the contrast medium. It is preferable to use a syringe of 3 cc. capacity. Those of greater capacity only interfere with the injection. They necessitate greater pressure of the liquid to overcome the resistance of the needle and the lumen of the deferens. Not infrequently the needle slips out of it and the contrast medium is scattered on all sides.

(*j*) when the injection is finished the deferens is buried. We generally apply two temporary ligatures of catgut, above and below the puncture, to prevent regurgitation of the contrast medium through the wound and the extravasation of the secretion of the epididymis. Suture of the fibrosa with very fine catgut.

(*k*) closure of the skin wound with hooks or with a continuous catgut suture and a protective dressing of the wound. When we suture the skin with catgut we keep the two ends of the thread to fasten a bit of gauze over the small operative wound.

Variations of this technique may be used, depending on the individual case. For example, if it is difficult to fix the deferens in the skin with the Backhaus forceps or a silk suture the incision is made transversely below the root of the penis (Oelecker) or longitudinally and medially in the raphe of the scrotum, after the infiltration of the anesthetic.

The vasa deferentia will be looked for on each side depending on the possibilities at the moment.

Boeminghaus in some cases fixes them together in the center of the wound. This same author gives preference to vasopuncture and precedes it with a small incision in the wall of the deferens in order to expose the lumen better.

These are small details which should never be forgotten as they settle certain difficulties of the moment. In exceptional cases the vas deferens is sectioned (vasotomy).

Obliteration of the deferens does not occur very frequently; it is to be noted that sometimes it is exaggerated traction that produces the obstacle by creating an elbow.

The possibilities of their being obliterated by trauma depends a great deal on the technique; that which we use, which is very simple, avoids this.

The indurative infiltration of the cord which accompanies the cicatricial healing of the operative wound, and even traumatic epididymitis, which sometimes occurs, do not cause such obstruction.

The existence of spermatozoa in the "exprimate" and fecundation were observed by us in cases in which such manifestations occurred on both sides, operated on by the old technique of Luys.

The contrast media used for both transdeferential and transurethral injection for catheterization of the ejaculatory ducts are Merck's neo-iodipin 20 per cent and Lafay's lipiodol, Schering's uroselectan and Bayer's perabrodil (ascending) and Heyden's thorotrast.

The experiments of Dobrazanieck in vaso-epididymo-vesiculography show that thorotrast is the preferable contrast medium, as it has been proved by histological examination that it does not cause the least injury to the tissues and organs into which it is injected. The same is true of perabrodil and uroselectan. They should therefore be the contrast media selected for vesiculography by the ejaculatory route, as they do not present the danger of the oily contrast media (that of embolism) when venous and arterial influx occurs.

Extravasations by perforation, fissuring or rupture of the vesicle and injections outside the vas deferens either of oily contrast media or medicinal solutions are free of danger, and therefore they are suitable for injection into the tissues. They are reabsorbed unless infection becomes established at the site of the trauma.

We have used neo-iodipin most fre-

quently. In addition, we have used 10 per cent collargol, as used by Belfield, iodoform used by Bungener (1901) and von Saar (1919), 5 per cent mercurochrome, and recently 0.10 per cent rivanol, when at the same time as roentgenography a medicinal instillation is to be given for treatment.

In irrigations of the vesicles undertaken in sterile and vasectomized patients, those who had had epididymectomy performed and those with chronic inflammation of the seminal vesicles, using the deferential route, we added to the therapeutic drug for the accompanying roentgenography neo-iodipin in 44 cases and thorotrast in 2 cases.

In irrigation by the ejaculatory route (5 cases) we used neo-iodipin in only one. Although in one or the other case there was extradeferential injection with immediate or late regurgitation of the neo-iodipin through the operative wound, no complication resulted.

Puncture and aspiration of the extravasation settled the situation favorably. The amount of contrast to be injected varies, depending on the route used (ejaculatory or deferential).

If the ejaculatory route is used not more than 1 to 1.5 cc. or at most 3 cc. can be used (on each side). It is a blind injection made without control as the capacity of the vesicles and the spermatic tract is not known in advance. During the injection the reflux of contrast medium indicates exactly the capacity of the distended vesicle. Sometimes the injection is followed by an acute attack of epididymitis.

On injection through the vas deferens, the amount injected need not be more than 3 cc. Here any amount that exceeds the capacity of the injected vesicle flows back through the bladder if the ejaculatory duct is permeable.

A sensation of pain or distention indicates obstruction of the ejaculatory duct and prevents the continuation of the injection.

Chauvin tells of intense pain, colic of the vesicles with nausea, vomiting and syncope when the injection has been made too forcibly (not oily contrast).

Barney recommends the previous injection into the vas deferens of 1:100 novocain.

Recently we have used the same method; but we realize that in cases of obstruction of the ejaculatory duct the anesthesia prevents the sensation that would control the continuance of the injection of contrast.

Once the vesicles are reached by any of the routes described, it is necessary for the radiologists and the urologists who are specialists in roentgenology to remember that the roentgenogram will reproduce only the lumen of the vesicles and spermatic tracts, with their anatomical structure with its many variations and subject to the modifications brought about by diseases of these organs and those near them.

In general, the roentgenogram will show lack of filling, slight filling of a lumen decreased in size or exaggerated filling from distention or dilatation of the cavities of the organ (ectasia), or finally extravasation, reflux, etc., when they are produced. The vesiculograms will therefore be perfect with distinct lines or increased in size by diffusions around the image, revealing extravasations.

If the images are repeated later they will show progressive emptying, indicating that the contrast is expelled and not absorbed by the organ (Hendriock, Athayde Pereira) (Fig. 1 and 2).

It is possible if there is great distention by hyperpressure that vesiculolymphatic or vesiculovenous refluxes will occur from fissuring of the wall, such as have been seen in urethrography, pyelography, etc.

In order that the roentgenogram may not show contrast medium which has flowed back into the bladder when the injection is made by the deferential route, and which could spoil the vesiculogram, it is customary to sound the patient and remove that contrast medium by multiple irrigations of the bladder.

The roentgenogram should not be taken until it is definitely known that this has been accomplished.

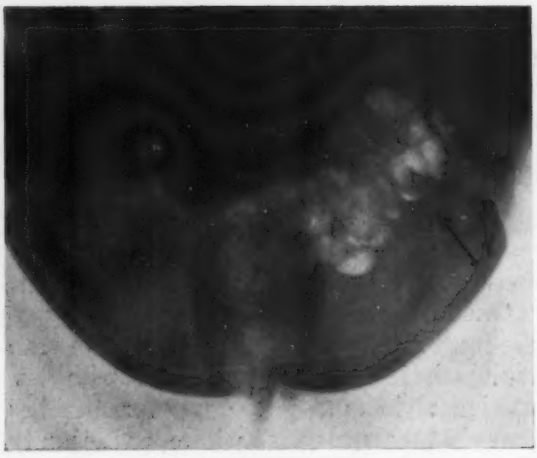

Fig. 1. Evacuation on the second day.

Fig. 4. Incomplete filling of the vesicles. Hypoplasia of the left vesicle.

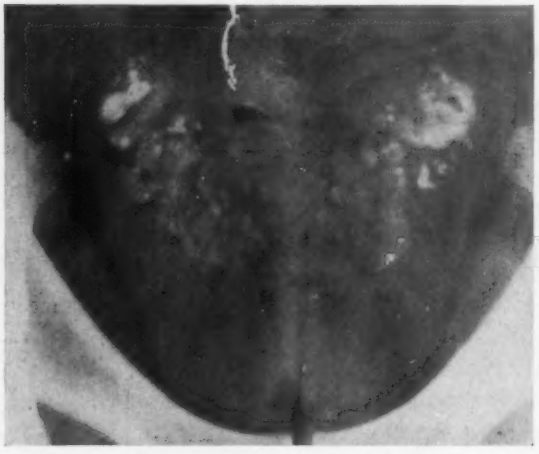

Fig. 2. Emptying on the third day.

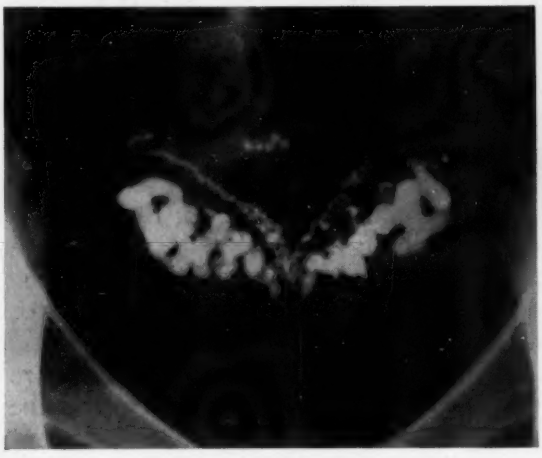

Fig. 5. Complete filling. Seminal vesicles clearly shown.

Fig. 3. Mixture of contrast medium with the vesicular secretion

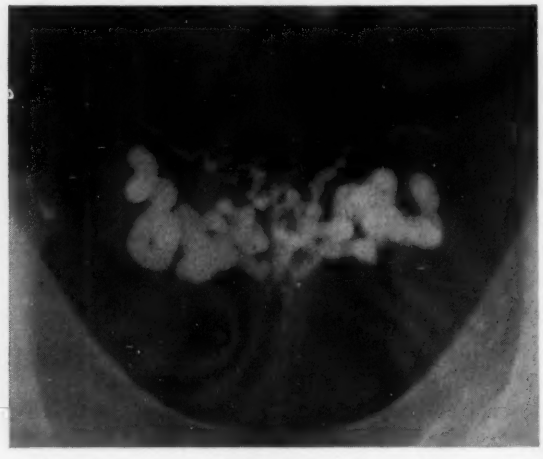

Fig. 6. Complete filling. Seminal vesicles clearly shown.

Roentgenograms are taken in only two positions: anteroposterior and axial. In the former the vesicles present horizontally or in a vertical direction. In the axial position they are seen in the anteroposterior or transverse direction.

These roentgenograms present different appearances, depending on the method of filling:

(a) The oily contrast medium mixes with the secretion accumulated in the ampullae and vesicles. The image shows clear defects and dark zones of contrast* (Fig. 3). Sometimes innumerable spheres of contrast oil are reproduced.

(b) The filling is incomplete because of the small amount of contrast medium injected (Fig. 4).

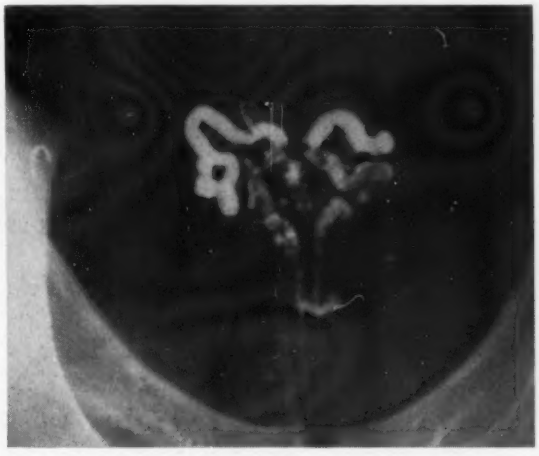

Fig. 7. Signs of partial emptying in both seminal vesicles.

(c) The filling is complete and the figure is perfect with distinct outlines (Fig. 5 and 6.)

(d) The image shows signs of emptying from contracture of the organ (Fig. 7). In general, this occurs after emptying of the contrast medium which flows back into the bladder.

(e) The image shows lack of filling of one or both vesicles because of obstruction of their duct or vas deferens.

* To avoid this mixture we generally precede the roentgenogram or irrigation of the vesicles by expression carried out the evening before. The vesicles are emptied and in condition to receive the contrast medium or bactericidal drug.

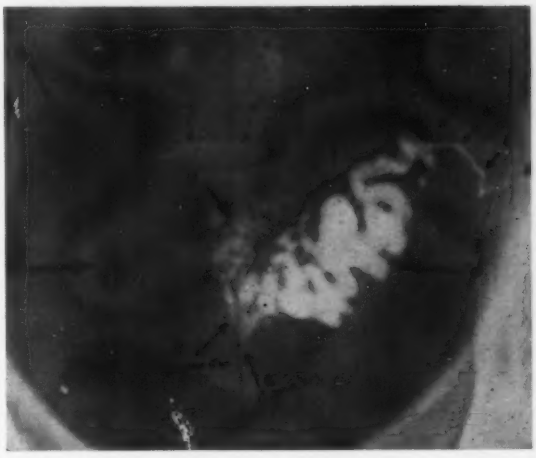

Fig. 8. Absence of filling of the right vesicle from obstruction of its duct (chronic inflammation).

All of these particulars are important in the description given by the roentgenologist; and especially he should use terms that are strictly anatomical and accurate. These are the designations used in daily practice: lumen of the deferens, ampullar lumen, ejaculatory ducts, ejaculatory sinus, vesicles or vesicular lumen.

As to the ramifications of the vesicles the terms used are: ascending portion, reflex portion, diverticula, secondary and supernumerary ramifications, etc.

The term "pasty images," used by some urologists, has nothing to do with pastiness and much less with "pastiness with the vesicular molds of Luys," a term used by

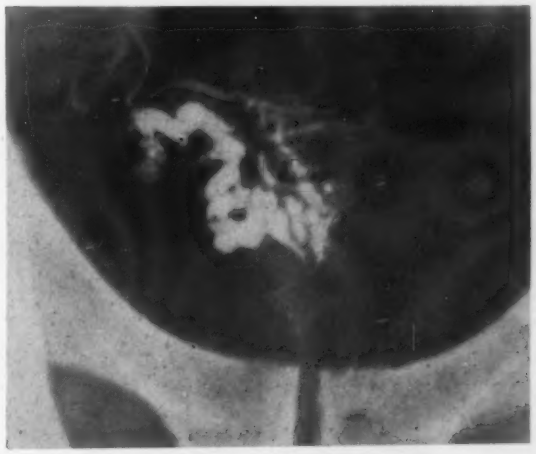

Fig. 9. Absence of filling of the left vesicle from obstruction of its duct (chronic inflammation).

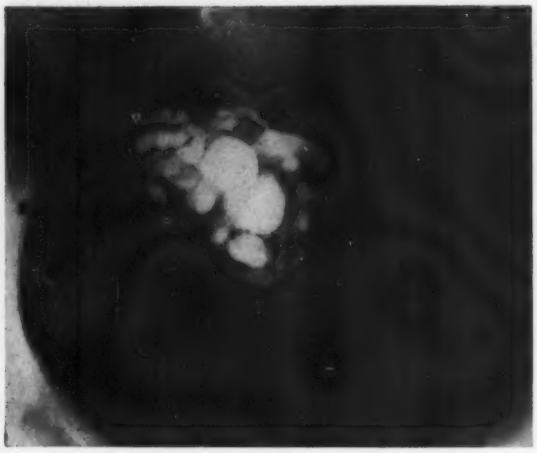

FIG. 10. Congenital unilateral absence of the left seminal vesicle.

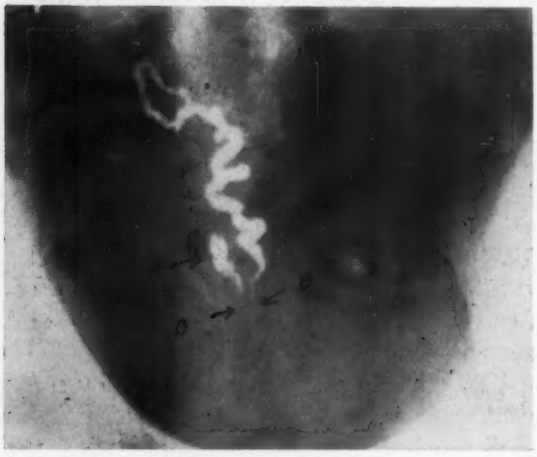

FIG. 11. Bilateral absence of the seminal vesicles.

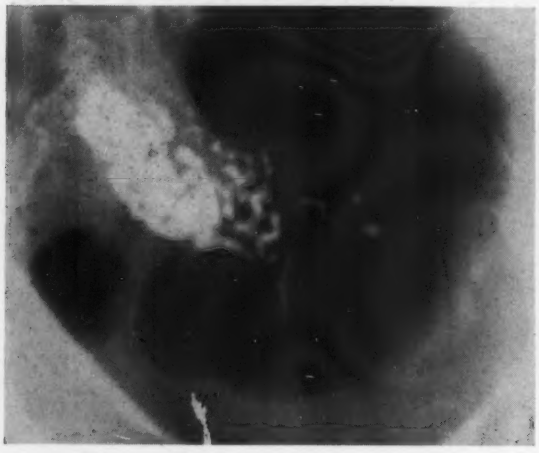

FIG. 12. Hypoplasia of the left seminal vesicle.

some specialists. These images only show the presence of pure contrast medium in a vesicle with a dilated lumen, without the least emulsion or dilution with vesicular or ampullar secretion.

They indicate mechanical distention or dilatation from ectasia of the vesicle, but never inflammation of the organ: something which can only be determined by the clinical symptomatology in conjunction with local examination (palpation, local exploration, posterior urethroscopy) and from the prostatovesicular "exprimate."

Another point which should not be forgotten is an accurate knowledge of the pathological anatomy of diseases of the seminal vesicles, in order to understand and explain the images which differ from the usual anatomical appearance.

It is possible that the roentgenogram may show the following congenital anomalies:

(a) A complete unilateral vesiculogram with only a deferens and ampulla on the opposite side (Fig. 10).

(b) A unilateral vesicle without a vesicle and deferens on the opposite side.

(c) Absence of both vesicles with presence only of the ampullae and vasa deferentia (Fig. 11).

(d) Rudimentary image of the vesicle (hypoplasia), which may be unilateral or bilateral (Fig. 12 and 13).

(e) A double image of the vesicle, uni-

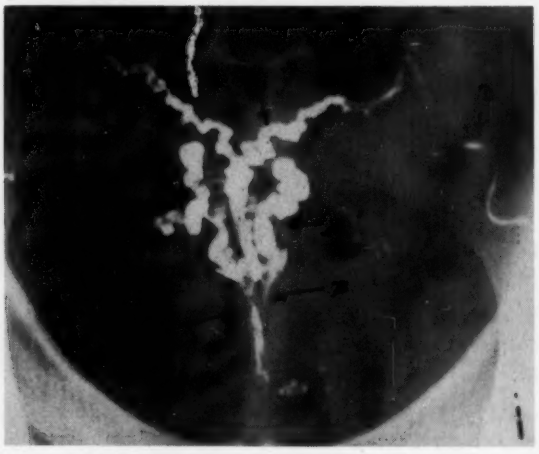

FIG. 13. Bilateral hypoplasia of the seminal vesicles.

lateral or bilateral (Fig. 14, 15 and 16).

(f) Communication of one vesicle with the ureter.

(g) Communication of the vas deferens with the ureter.

(h) Communication of the two vasa deferentia with each other.

(i) Ejaculatory ducts obliterated, fused or absent.

(j) Communication of the ejaculatory ducts with the ureter.

In inflammatory diseases the vesiculogram undergoes some changes in appearance which vary with the stage of development of the disease.

In acute inflammations, as there is edematous swelling of the walls and of the mucosa, the lumen of the vesicle is reduced and the image obtained shows only a slender thread of contrast medium which has penetrated it.

In other cases the acute inflammatory reaction follows ectasia of the infected vesicle contents resulting from obstruction of the ejaculatory ducts or its excretory canal.

A roentgenogram in these cases might show dilatation of the lumen. But naturally the conscientious specialist would not think of making a roentgenogram of the vesicle in such cases, which would increase its contents and cause the patient acute suffering.

In superficial chronic inflammations and in latent infections, the lumen of the vesicle does not show in the contrast roentgenogram any changes which make it possible to affirm or deny the existence of disease (Fig. 17 and 18).

In deep chronic inflammations with indurative thickening of the walls of the vesicles and ampullae, or even sclerosis or adhesions from perivesiculitis, it is clear that the lumen will be constricted or will not show at all on account of being obstructed temporarily or permanently (Fig. 19, 20, 21, 22 and 23).

In frank empyema of the vesicle in which the organ loses its muscle tonus, and its walls are thinned by the temporary but

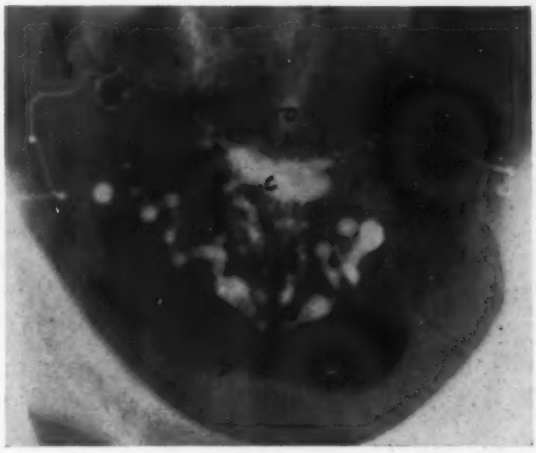

Fig. 14. Duplication, or supernumerary vesicle on the left side.

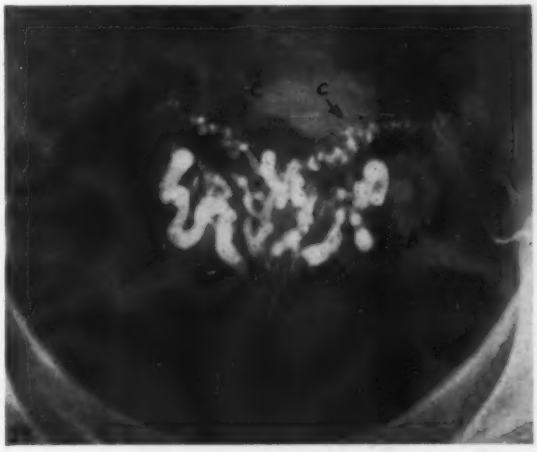

Fig. 15. Duplication, or supernumerary vesicles on both sides.

Fig. 16. Duplication, or supernumerary vesicle on the right side.

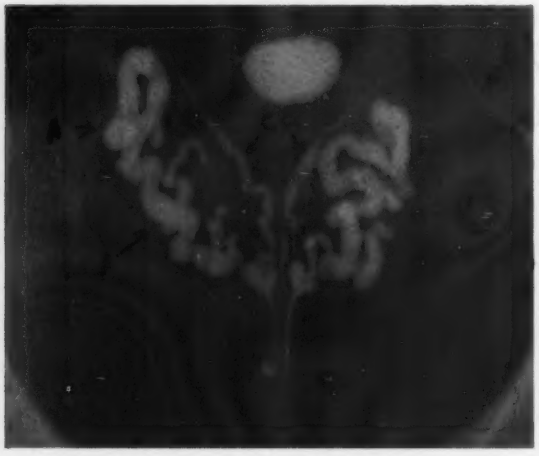

Fig. 17. Superficial chronic inflammatory condition without changes in the vesiculogram.

repeated distention by the purulent contents, the vesiculogram will show the dilatation (roentgenogram of Puigvert), but a clear outline will be preserved without diffusion around the image. The same thing happens in uninfected cystic dilatations of the vesicles and in dynamic disturbances of infected vesicles (Fig. 24 and 25).

In gangrenous vesiculitis, which is very rare, with perforations into the bladder, the rectum or into the bed of the vesicle itself, which may or may not be accompanied by ischiorectal abscess, certainly an atypical image would be obtained; but in these cases which are accompanied by a bad general condition or even sepsis, no specialist would think of making a roentgenogram of the vesicles for purposes of diagnosis.

Fig. 18. Superficial chronic inflammatory condition without changes in the vesiculogram.

In tuberculosis it is sufficient to bear in mind its forms of macroscopic diagnosis: sclerocaseous, frank caseous and hydropic-caseous and what is known of the course of its development, to be convinced that the lumens of the ampullae and vesicles may be permeable and give a faint image because of constriction from thickening of the walls of the organ, or may be obstructed by caseous masses which do not permit of penetration of the contrast.

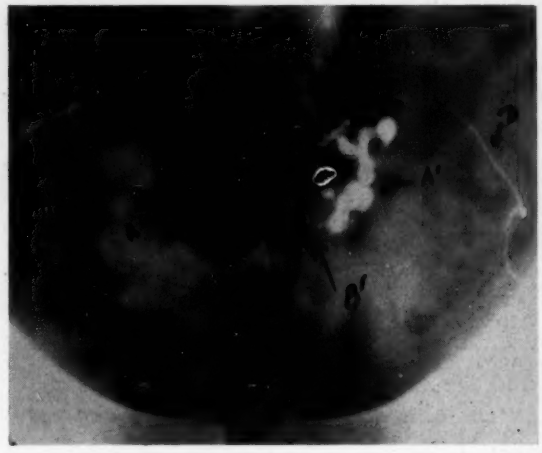

Fig. 19. Deep chronic inflammatory condition. Indurative thickening of the walls of the vesicles. The lumen of the right vesicle is a slender thread. Obstruction of the ejaculatory duct on the left.

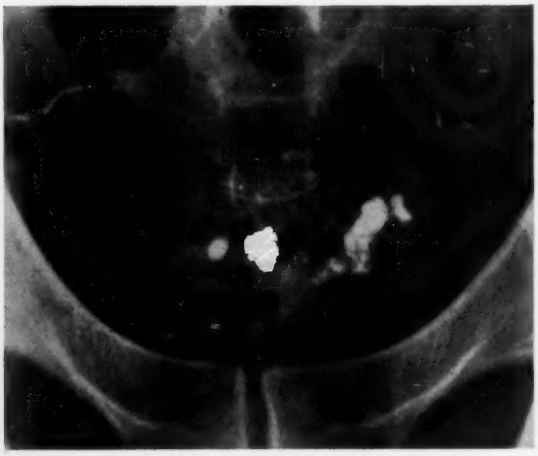

Fig. 20. Chronic inflammatory condition. Indurative thickening of the wall of the right vesicle.

Tumors as well as cysts may be revealed by transperineal filling (case of Boeminghaus); nevertheless malignant tumors may constrict the lumen or obstruct it, or in an advanced stage, as Gutierrez observed, when there is destruction of the walls, may give images of intra- and extravesicular ectasia (Fig. 26).

Calcifications are shown in the exploratory roentgenogram itself, as in the case of an old tuberculous case described by

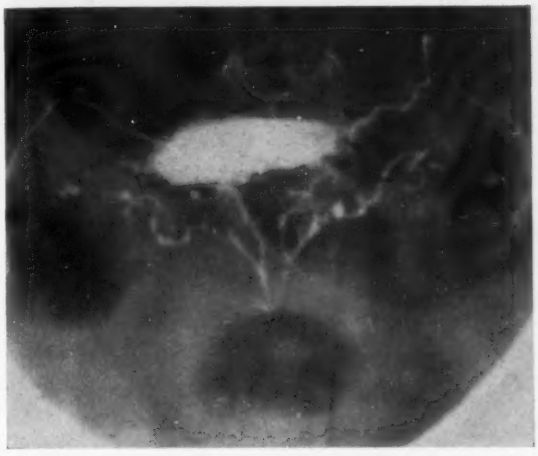

Fig. 21. Deep chronic inflammatory condition. Indurative thickening of the walls of the vesicles on both sides. The lumen of the vesicle is a slender thread.

Fraenkel (Handb. der Urolog., Vol. v) and in those of Hoffer and Lossen (deferential).

Finally, diseases of the prostate, bladder and rectum, organs which are related by close proximity to the vesicles, may cause changes in the roentgen image.

It is chiefly tumors that compress the vas deferens, the vesicles and the ejaculatory ducts, totally or partially preventing their filling (roentgenogram of Puigvert).

Adenoma of the prostatic urethra, depending on whether its growth is intravesical or perineal, prevents complete filling and changes the position of the vesicles in anteroposterior roentgenograms, sometimes elevating the images greatly and sometimes pulling them down below the pubic arch (roentgenograms of Belfield and Rolnick, Hendriock, Athayde Pereira) (Fig. 27).

Many cases of primary or recurrent ab-

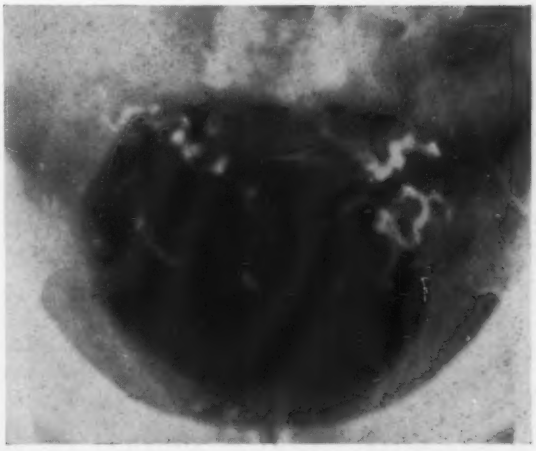

Fig. 22. Deep chronic inflammatory condition. Indurative thickening of the walls of both vesicles. The vesicular lumen is reduced in size.

scesses of the prostate may be shown to be chronic empyemas of the vesicles which have opened into the posterior urethra (Morissey).

These are the accepted ideas on the subject; and they show that there is no doubt as to the exact way of interpreting the vesiculograms, no matter whether they are obtained by the ejaculatory or the deferential route.

The indications for vesiculography, to which we referred in the beginning, are certainly very extensive and are necessary, in conjunction with excretory urography,

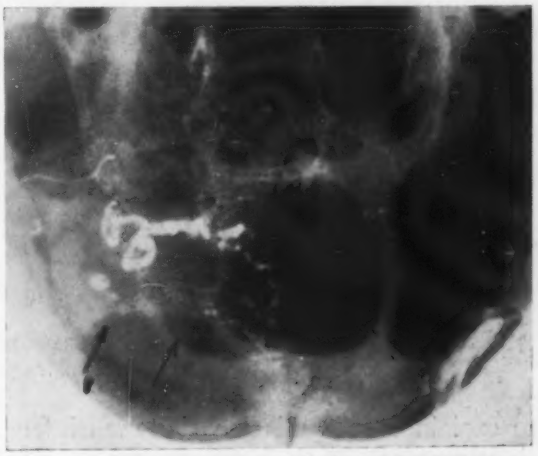

Fig. 23. Deep chronic inflammatory condition. Indurative thickening of the walls of the vesicles. Obstruction of the left ampulla and vesicle. The lumen of the right vesicle is a slender thread.

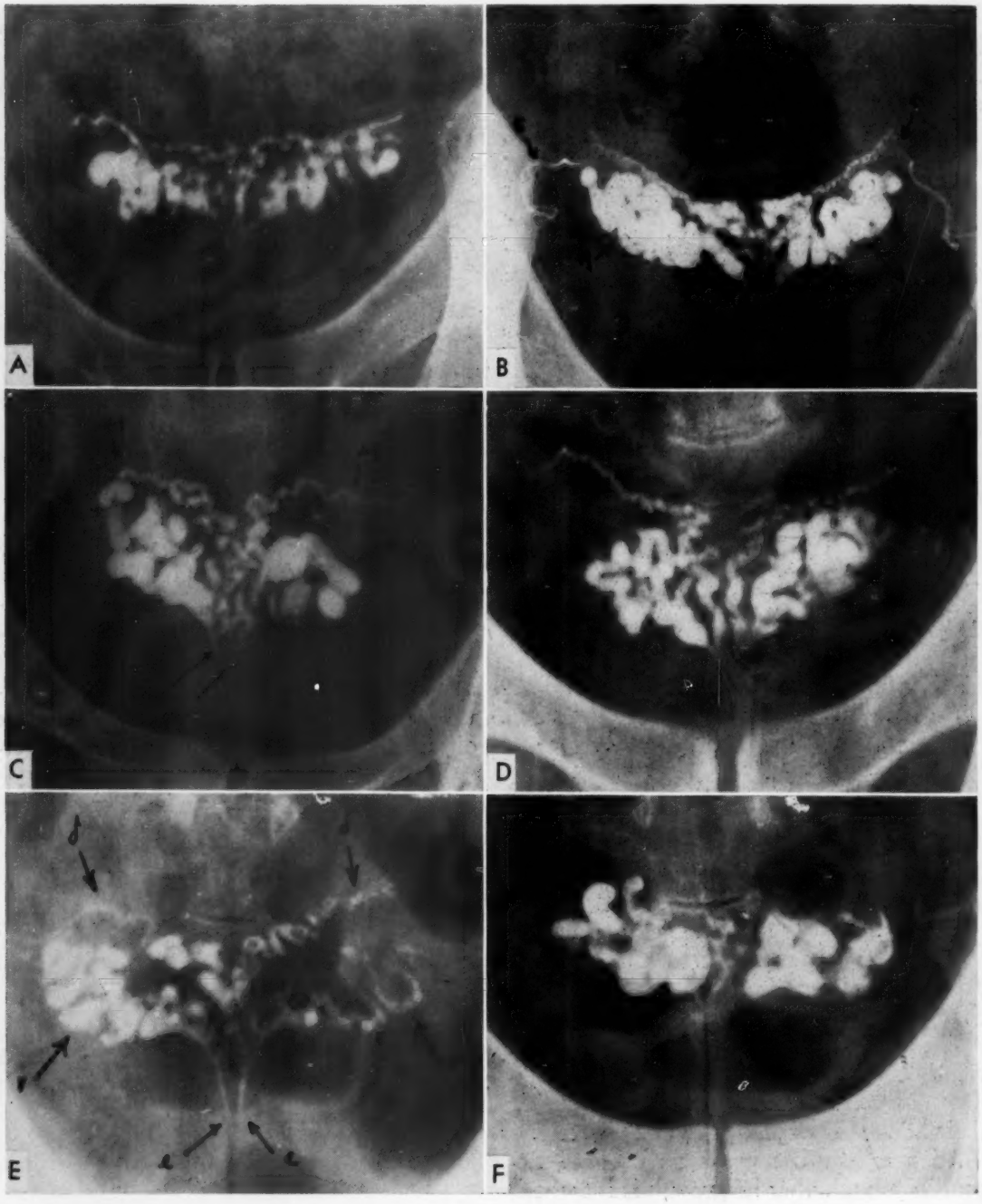

Fig. 24, (*A*) (*B*) (*C*) (*D*) (*E*) (*F*). Vesiculograms. Chronic inflammatory conditions with moderate disturbances of vesicular dynamics, unilateral or bilateral.

to explain certain relations between infectious processes of the excretory tracts, and even of the kidneys, and latent or manifest infections of the male adnexa, and particularly to explain many cases of recurrent urinary lithiasis, unilateral or bilateral.

I have spoken before of the possibility of its revealing acquired anomalies and defects of the vesicles resulting from disease of the neighboring organs.

In inflammatory diseases it is always useful, whenever irrigation of the organ is

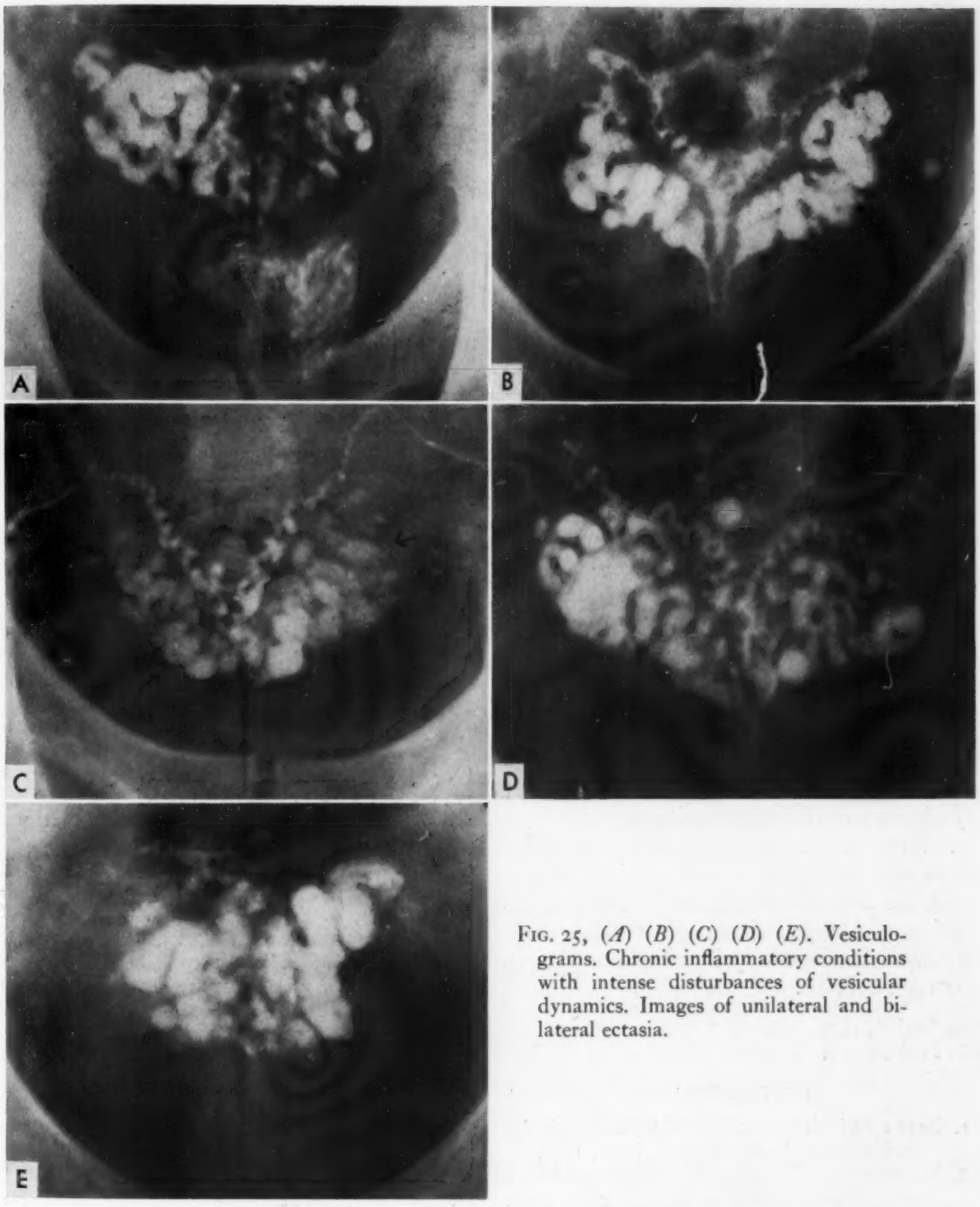

Fig. 25, (*A*) (*B*) (*C*) (*D*) (*E*). Vesiculograms. Chronic inflammatory conditions with intense disturbances of vesicular dynamics. Images of unilateral and bilateral ectasia.

practiced as a method of treatment.

The roentgen images obtained may show at once the results that may be obtained by conservative treatment or indicate in advance a curative operation.

Finally a large field of observation is furnished by its systematic practice in preparatory vasectomy for surgical extirpation of adenoma of the prostatic urethra and in vasectomy for male sterilization.

The collection of vesiculograms which illustrates this paper was obtained solely in our private clinic.

They were from patients who were undergoing treatment for chronic spermatocystitis by irrigation of the seminal vesicles

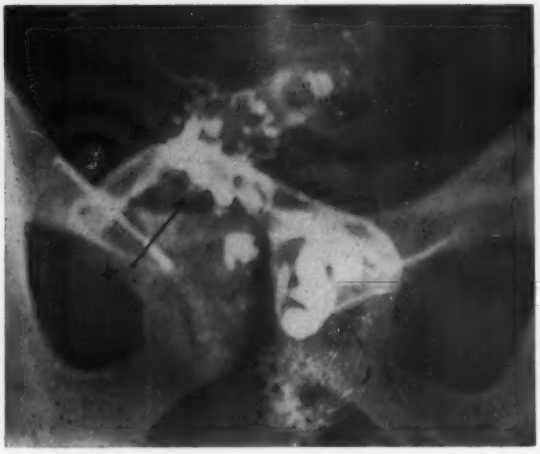

Fig. 26. Seminal vesicles in a case of cancer of the prostate. Deformities of the vesiculogram on both sides. The contrast medium has penetrated into the niches of the tumor also.

Fig. 27. Seminal vesicles in adenoma of the prostatic urethra with subvesical development. The vesiculogram is below the pubic arch.

to which contrast medium was added for the purpose of supplementary investigation.

This is the first time that we have documented the clinical and anatomopathological occurrences in the seminal vesicles by this method; it includes congenital anomalies, the possibilities resulting from inflammatory processes and certain modifications of the vesiculogram brought about by diseases of the neighboring organs.

All the roentgenograms were made by us in the roentgenological services of the Casa de Saude Matarazo (under the direction of Dr. J. Priore), of the Sanatorio Santa Catharina, in private offices and in our own service.

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PULMONARY EMBOLISM DOES NOT NECESSARILY MEAN PULMONARY INFARCTION*

A CASE REPORT

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IN MEDICAL thinking, embolism or thrombosis of the pulmonary vessels has generally been considered synonymous with pulmonary infarction. Clinical and experimental studies have shown that simple pulmonary embolism may occur without pulmonary infarction. Radiologists need to be aware of this in considering the differential diagnosis of chest lesions.

Anatomically the lungs possess a dual blood supply, the pulmonary and the bronchial arteries, the latter arising from the aorta and increasing in size when the pulmonary arteries are occluded. Karsner and Ash[4] in their studies concluded that simple pulmonary embolism produced no true infarction. They considered the degree of stasis in the pulmonary circulation as one of the most important factors in the production of pulmonary infarction. However, by introducing lead shots into the pulmonary circulation of dogs, Steinberg and Mundy[8] showed that *sudden complete obstruction* of the pulmonary arteries would produce a hemorrhagic infarct without other contributing factors. Apparently thorough experimental investigations are yet to be done to indicate the cause for infarction in gradual and progressive occlusions. Our review of the American literature suggested to us that previous embarrassment of the cardiovascular system was necessary for pulmonary occlusion to produce infarction.

Shapiro and Rigler[7] have recently described the roentgen findings in 3 cases, occurring postoperatively, of pulmonary embolism without infarction. These significant findings are: (1) segmental increased radiability of the lung due to ischemia, (2) abrupt termination of the major arterial branches at the site of embolus, (3) relative absence of vascular pattern in the involved areas and (4) dilatation of the main pulmonary artery or arteries proximal to the embolus. We wish to report a case with similar roentgen findings. As will be noted below, our case also presents evidence of cor pulmonale.

Whereas both pulmonary embolism and infarction are commonly considered as postoperative complications, they are by no means rare in medical cases.[1,3] In a monumental autopsy series of 370 cases of pulmonary embolism reported by Hampton and Castleman[3] in 1940, only 40 per cent were postoperative. Of the remaining 60 per cent, only one-half were cardiac cases. These investigators also found that, with the exception of the cardiac cases, by far the greatest majority of the emboli arose from the veins of the legs. Another study by Carlotti and his associates[1] revealed that pulmonary embolism in medical patients was more than twice as common as in surgical patients.

These observations should stimulate interest in this condition, particularly when it is realized that many such cases come to necropsy without the diagnosis being suspected or established. Furthermore, recent advances in therapy have made recognition of this condition even more imperative.

CASE REPORT

I. D., a Caucasian male, aged forty-three, entered the hospital with a history of gradual progression of exertional dyspnea and minimal fleeting chest pain of four months' duration.

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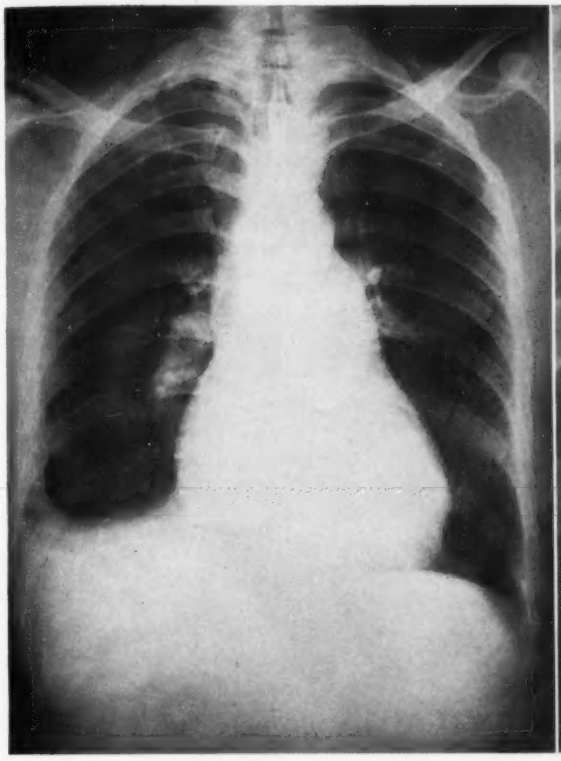

Fig. 1

Fig. 2

Fig. 1. The posteroanterior view of the chest demonstrates enlargement of the pulmonary artery segment of the cardiac shadow, dilatation of the right pulmonary artery, and a diminished vascular pattern, particularly in the right middle and lower lobes. There is pleural thickening on the right with obliteration of the lateral costophrenic space. The only evidence of pulmonary infarction is the small ovoid shadow underlying the left fourth anterior interspace.

Fig. 2. An enlarged view of the right hilar area shows the conspicuous absence of the normal vascular pattern in the adjacent lung. The abrupt termination of the right pulmonary artery is also well demonstrated.

At entry the dyspnea was so severe that he was unable to walk more than 20 feet without extreme discomfort. Cyanosis of the lips developed two days before hospitalization but there was no history of previous cyanotic episodes. Cough, productive of brownish sputum, was noted for two days but there was no frank hemoptysis. Ankle edema had not been present. Other subjective complaints were nausea and vomiting, epigastric pain relieved by food, and chest "tightness," all present during the last week.

Prior to the present illness, the patient had been entirely well except for an upper respiratory infection one year previously, after which he developed a lump in the right axilla which disappeared following roentgen therapy elsewhere. The axillary mass recurred four months prior to hospitalization. Biopsy was reported to show lymphadenitis with no evidence of malignant cells or lymphoma. Occupational history disclosed that the patient had quit his job as a painter ten years before because of "lead poisoning" and had subsequently been a salesman.

Physical examination revealed a well developed, well nourished dyspneic patient with slight cyanosis of the lips. The blood pressure was 110 systolic, 80 diastolic. The pulse rate was 116 and the respiratory rate, 28. Temperature taken orally was 97.6° F. The heart was not enlarged to percussion, but a grade III blowing systolic murmur was heard over the apex. The lungs were clear to physical examination. Epigastric tenderness and a liver enlarged 4 cm. downward were noted. The extremities showed no visible or palpable edema.

Routine laboratory studies revealed a hemoglobin of 15 grams, white blood cell count of 13,400 per cubic millimeter, and a differential

count of 71 per cent neutrophils, 5 per cent stab cells, and 24 per cent lymphocytes. The urine contained albumin and occasional pus cells; the specific gravity was 1.027. The blood serology was negative. Venous pressure in the arm was 16 cm. saline. Circulation time was 18 seconds from arm to tongue and 8 seconds from arm to lung.

Roentgen examination of the heart on the morning of hospital entry revealed definite generalized increase in lung radiability. A 12 by 8 mm. ovoid density was seen at the left fourth anterior interspace on the posteroanterior film, but there was otherwise no pulmonary infiltration or consolidation. The right base showed obliteration of the lateral costophrenic sulcus with thickened pleura.

Further clinical study of the patient was interrupted when twenty-four hours after admission he suddenly developed severe oxygen

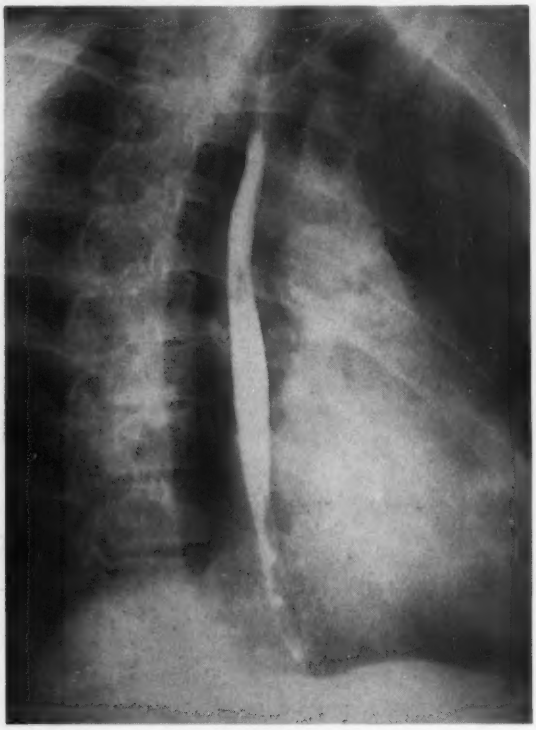

FIG. 3

FIG. 4

FIG. 3. The right anterior oblique projection shows dilatation of the right pulmonary artery and the pulmonary conus.

FIG. 4. The left anterior oblique projection shows prominence of the anterior cardiac shadow consistent with the right ventricular enlargement.

right-sided cardiac enlargement with prominence of the pulmonary conus and enlargement of the pulmonary arteries (Fig. 1, 3 and 4). The smaller pulmonary vessels, however, were not prominent or engorged, and there was conspicuous absence of vascular markings in the lower portion of the right lung (Fig. 2). The main branches of the right pulmonary artery to the lower lung fields appeared to end abruptly (Fig. 1 and 2). This was not true at the left base where the vessels could be seen through the heart shadow on an overexposed posteroanterior grid film. There was slight hunger and profound cyanosis and died ten minutes later.

At autopsy the heart weighed 430 grams. The right ventricle appeared slightly dilated and hypertrophic. The left ventricle did not appear enlarged. The cardiac valves and coronary arteries demonstrated no gross pathological change. The heart chambers contained no antemortem clots. The veins in both lower extremities were traced. There were no thrombi on the right side but a thrombus in the left popliteal vein extended from the confluence of the posterior tibial and perineal veins to a point 8 cm.

above the knee joint. The upper third of the thrombus was definitely organized and possibly recanalized. Definite lines of Zahn were noted on the surface. The thrombus did not extend into any of the smaller contributing veins.

Study of the respiratory system revealed no increased fluid in the pleural spaces but there were some adhesions between the right lung and the diaphragm. The left lung weighed 500 grams and the right, 580 grams. The pulmonary conus and the right pulmonary artery were somewhat dilated. The main arteries supplying the right lower and middle lobes were occluded by old grayish thrombi. A small thrombus 2 mm. in diameter, was present in the artery supplying the anterior portion of the right upper lobe. The lung supplied by the occluded vessels was dry and slightly heavier than average but did not appear infarcted. A small area of recent infaction was found in the left lung.

Microscopic examination of the popliteal vein revealed a greatly thickened wall. In the lumen of the vein attached to a sclerotic plaque was a large organized and recanalized thrombus on the surface of which appeared a smaller, more recent thrombus (Fig. 5). Sections of the lung demonstrated numerous thrombi of different sizes and in different stages of organization. Some of the thrombi appeared very recent while others were completely organized and recanalized (Fig. 6 and 7). Several areas of the left

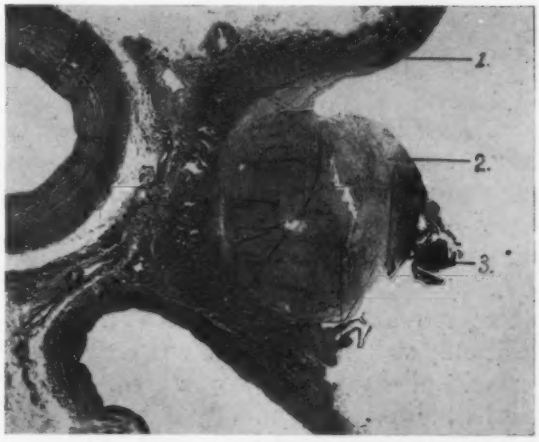

Fig. 5. Here is shown a photomicrograph of the left popliteal vein (*1*). An organizing thrombus (*2*) is attached to the greatly thickened intima. A recent thrombus (*3*) is loosely adherent to the old thrombus.

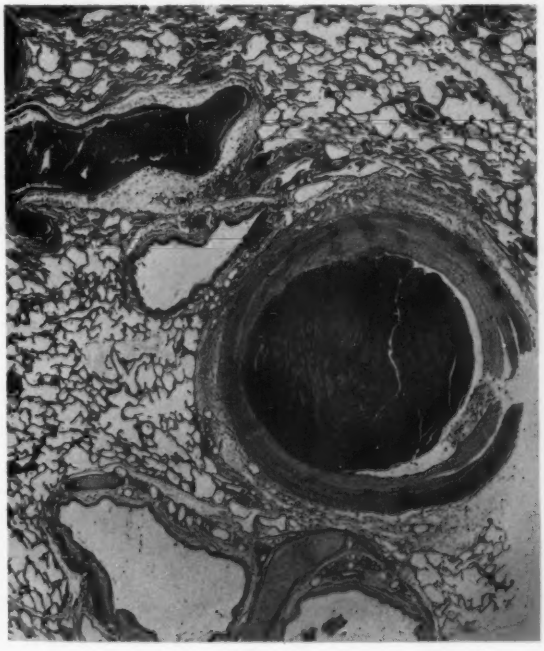

Fig. 6

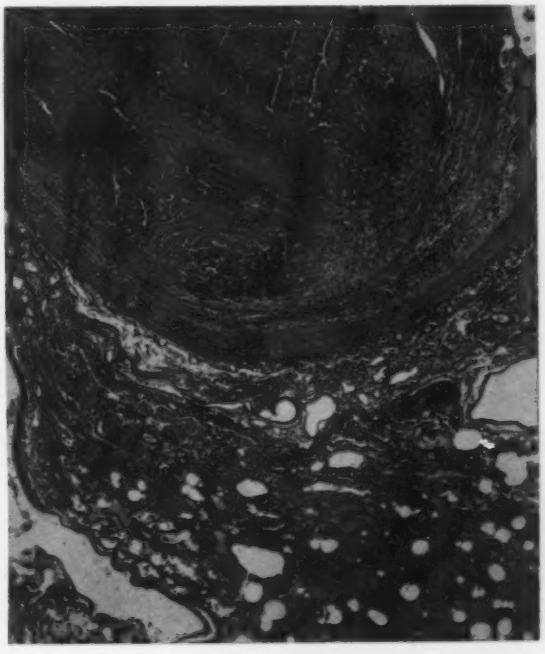

Fig. 7

Fig. 6. A recent thrombus in a branch of the pulmonary artery is shown in this photomicrograph. The thrombus is not organized and there is no evidence of infarction of the lung.

Fig. 7. This photomicrograph reveals old thrombus in a branch of the pulmonary artery showing fibrosis and recanalization at the periphery. Again there is no evidence of pulmonary infarction.

lung showed very recent hemorrhagic infraction, some of which were surrounded by zones of fibrosis.

Discussion. At autopsy there was massive thrombotic extension of old emboli into the pulmonary arteries with only minimal and very recent pulmonary infarction in this forty-three year old man with no known cardiovascular disease and with no symptoms referable to the lower extremities. The only striking symptom was progressive exertional dyspnea over a four month period, although terminally there was cyanosis and mild chest pain. Surgery is not believed to be a causative agent in this case. The only previous surgical procedure was the biopsy of a right axillary node done as an outpatient four months before. Autopsy showed no abnormality or thrombosis of the axillary veins. Organization of a large portion of the thrombotic extension of the embolus and cor pulmonale are evidences of the long-standing obstruction of the pulmonary vessels involved.

SUMMARY

1. Massive pulmonary thrombosis following embolus without or with minimal infarction is possible. One additional case is reported.

2. The roentgen findings in this case are similar to those recently reported by other investigators and consist of: (a) segmental increased radiability of the lung, (b) abrupt termination of the major arterial branches at the site of embolus, (c) relative absence of vascular pattern in the involved area and (d) dilatation of the main pulmonary artery or arteries proximal to the embolus. Our case also showed cor pulmonale.

3. The importance of establishing the roentgen diagnosis of this condition in medical as well as in postoperative cases is pointed out.

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We wish to express our appreciation to Dr. Howard Gomes of the Department of Pathology, and to Mr. Edward Hamilton of the Department of Visual Education for their contribution in the preparation of the illustrations.

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CINEFLUOROGRAPHIC STUDIES OF CARDIOVASCULAR DISEASE*

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IN 1897, one year after the discovery of the roentgen ray, MacIntyre produced a motion picture illustrating the movements of a frog's hind leg by obtaining a number of simple roentgenograms of various positions and synthesizing movement by arranging them in sequential order. By 1909, Kaestle *et al.* had exposed thirteen roentgenograms in twenty-two seconds. Direct motion picture photography of images on a fluorescent screen awaited the development of efficient roentgen-ray apparatus, sensitive fluorescent screens and motion picture film, and optical systems having sufficient resolution and aperture. Between 1921 and 1938 Reynolds[8,9] developed equipment which produced highly satisfactory cinefluorograms. A number of investigators have made significant contributions using the cinefluorographic technique as a research tool.[1,2,3,4,7,12,13] Until recently[5,6,11] little attention has been directed toward the application of cinefluorography to clinical problems.

Cinefluorography is particularly suited to the study of repetitive activity with a short cycle length, or of phenomena which occur too rapidly for adequate observation during roentgenoscopy. The information obtained by continuous cinefluorographic angiocardiography is illustrated in an infant with coarctation of the aorta.

METHOD

The components of the equipment are indicated diagrammatically in Figure 1*A*. A Patterson B_2 fluorescent screen (*1*) is mounted in a 14 by 17 inch cassette from which the metal back had been removed. Two, front-silvered mirrors (*2*, *3*) reflect light from the fluorescent screen a distance of 5 feet to a Bolex 16 mm. motion picture camera (*4*) mounted in a lead-lined compartment. The camera release is activated by a solenoid (*5*), controlled by a roentgen-ray timing switch in the control booth. A 5 by 7 inch fluorescent screen (*6*) can be photographed directly by swinging one mirror (*3*) out of the way. The component parts are installed in a light-tight box for use under ordinary room illumination. The apparatus is routinely used on a vertically adjustable platform, mounted on a wheeled cart (Fig. 1*B*). During special procedures, such as angiocardiography, the box is placed on the floor with the fluorescent screen level with the top of a roentgen table (Fig. 1*C*).

It is highly desirable to synchronize the camera with the roentgen machine. If the fluorescent screen is photographed at 16, 32 or 64 frames a second, periodic variations in film density produce flicker in the projected image because the shutter speed passes in and out of phase with the alternating current. This problem can be circumvented by setting the shutter speed at 15, 30 or 60 frames a second. The accuracy of the adjustment can be judged most readily by observing the light emitted from a strobotach through the camera shutter. For example, if the strobotach is flashing 900 times a minute, the film gate appears either continuously illuminated or completely dark when the camera speed is exactly 15 frames a second. Shutter speeds are slightly increased by a very tight spring tension, and decrease just before the spring becomes lax. More complicated apparatus synchronizing the roentgen-ray output with the camera shutter, has been described in a previous report.[10]

For cardiac or pulmonary cinefluorography, a film speed of 15 frames per second has proved most satisfactory. At this frame speed and with an f 1.4 lens, sufficient penetration is obtained by using 96 kv. and 175 ma. at a tube-screen distance of 40 in. for a posteroanterior view of an adult chest 21 cm. thick. The aperture of the

* Aided in part by the Washington State Heart Association, State of Washington Research Fund for Biology and Medicine and the National Heart Institute of the National Institute of Health, Public Health Service.

camera lens is wide open, and variations in chest thickness are compensated by varying kilovoltage and milliamperage.

The duration of exposure is limited by two factors: the heat storage capacity of the roentgen tube and, of greater importance, the exposure of the patient to radiation. A KX-1 roentgen-ray generator with a CRT 1-2 roentgen tube* has been used exclusively because the heat storage capacity of the solid copper rotating anode permits adequate exposures without exceeding the tube ratings. Since the effects of radiation on subjects are believed to be cumulative, cinefluorography is approached with full awareness of the dangers involved. Radiation at the level of the skin has been carefully charted with a Victoreen radiation meter. In the present study, 20 roentgens on the skin has been set as the maximum exposure except during angiography when this level has been doubled in a few cases. Exposures have not been repeated at intervals shorter than six months. The self-imposed limitation on roentgen-ray dosage has restricted the duration of exposure to 3.5–5 seconds for adult chest films.

While this apparatus is satisfactory for standard cinefluorography in adults and for angiocardiography in dogs, it is inadequate for human angiocardiography. Substituting an f 0.8 lens (Taylor, Hobson) for the 1.4 lens has considerably improved the efficiency of the equipment as indicated by the cases described below.

The most important single factor in producing successful cinefluorograms is the processing of the motion picture films in the laboratory. A number of films have been tested, and Eastman Kodak Linograph Ortho film has proved most satisfactory. This film is very sensitive to green light, but has inherent grain which cannot be avoided by the use of fine grain developers. Complete development in rapid roentgen-ray developers requires about six minutes; chemical fog on the film limits the time for development.

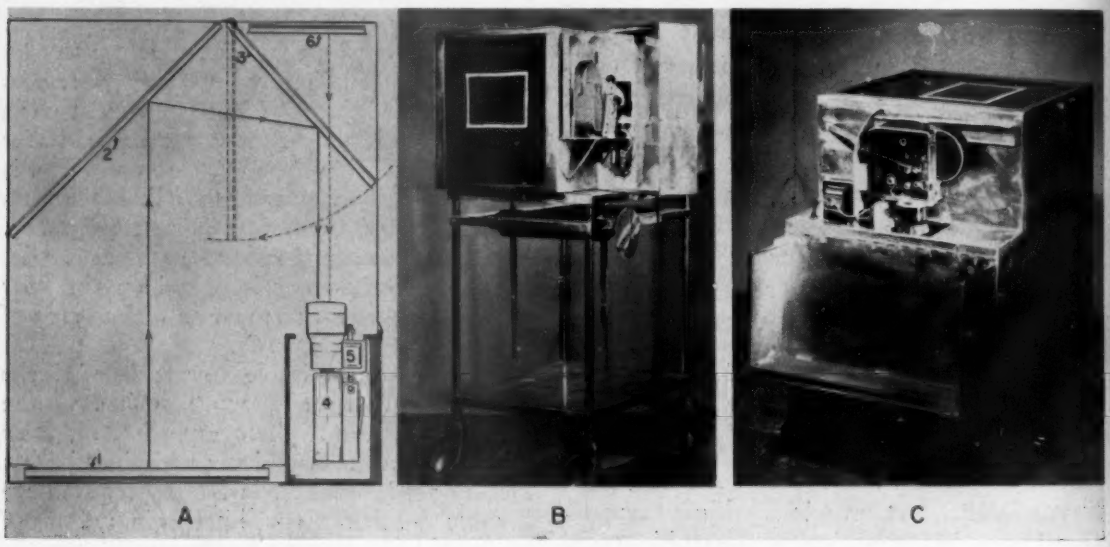

FIG. 1. The cinefluorographic equipment: (*A*) Schematic drawing as viewed from above, (*B*) mounted on the cart for routine use, (*C*) positioned on the floor for angiography.

RESULTS

Cinefluorography occupies a position between roentgenoscopy and roentgenography, combining the advantages of the two techniques. The movements of the heart borders and the configuration of the cardiac silhouette, viewed from various angles, have been recorded on more than 80 cases with congenital and acquired heart disease. These permanent records are of value in extended case studies and in reviewing the clinical findings (*e.g.*, postmortem or postoperatively). A few cinefluorographic case studies illustrate the advantages of the technique. Compared with the normal cardiac silhouette (Fig. 2*A*), the heart of

* Generously supplied by the General Electric X-ray Company for this study.

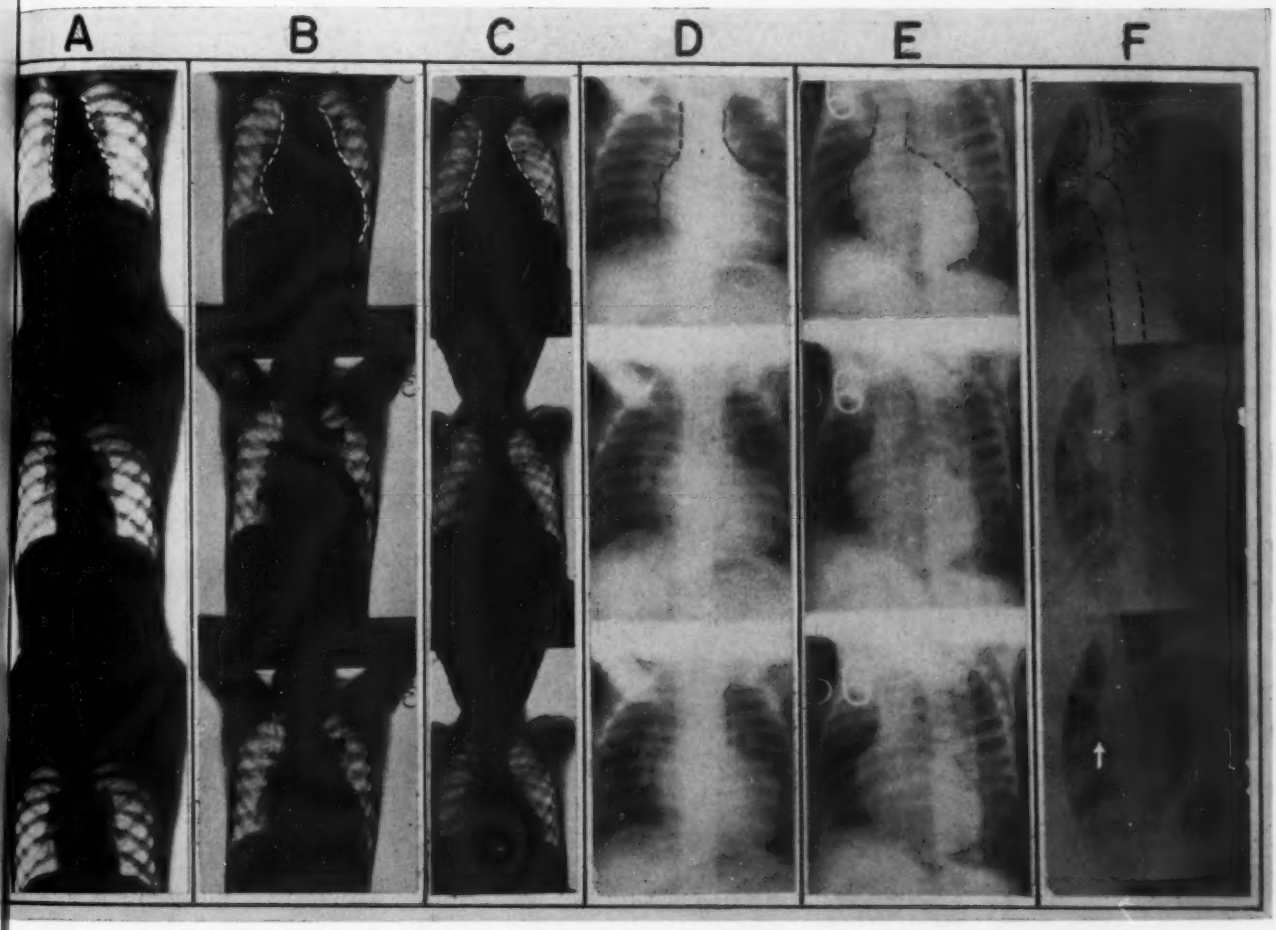

Fig. 2. Cinefluorograms of patients obtained with large screen coverage (*A*, *B*, *C*), small screen coverage (*D*, *E*, *F*), and retrograde aortogram (*F*) using f 0.8 lens.

the first patient with similar habitus (Fig. 2*B*) was markedly enlarged. The dilated pulmonary artery was associated with increased vascular markings in the lung fields, both of which pulsated vigorously. The roentgenograms and cinefluorograms were interpreted as indicating enlargement of the right atrium, right ventricle, pulmonary artery and left ventricle associated with increased pulmonary blood flow. A loud systolic murmur in the pulmonary area and a diastolic murmur in the mitral area were confirmed stethographically and a tentative diagnosis of Lutembacher's syndrome was made. The child died suddenly on the street and postmortem examination revealed the coexistence of a large interatrial septal defect and entry of the right pulmonary veins into the right atrium. The mitral valve was normal and the left ventricle was not enlarged. The right atrium and ventricle and the pulmonary artery were widely dilated. In retrospect, the diastolic murmur probably resulted from incompetence of the pulmonary valve.

In another case (Fig. 2*C*) the clinical findings were typical of a patent ductus arteriosus. The roentgenographic examination revealed a flattened left border, but no prominence of the pulmonary artery or vascular lung markings. Cinefluorograms reveal increased pulsation of the pulmonary artery. The diagnosis has been confirmed at operation and the ductus arteriosus interrupted.

An infant, eight months of age, with mild cyanosis was rotated into the left anterior oblique position during the cine-

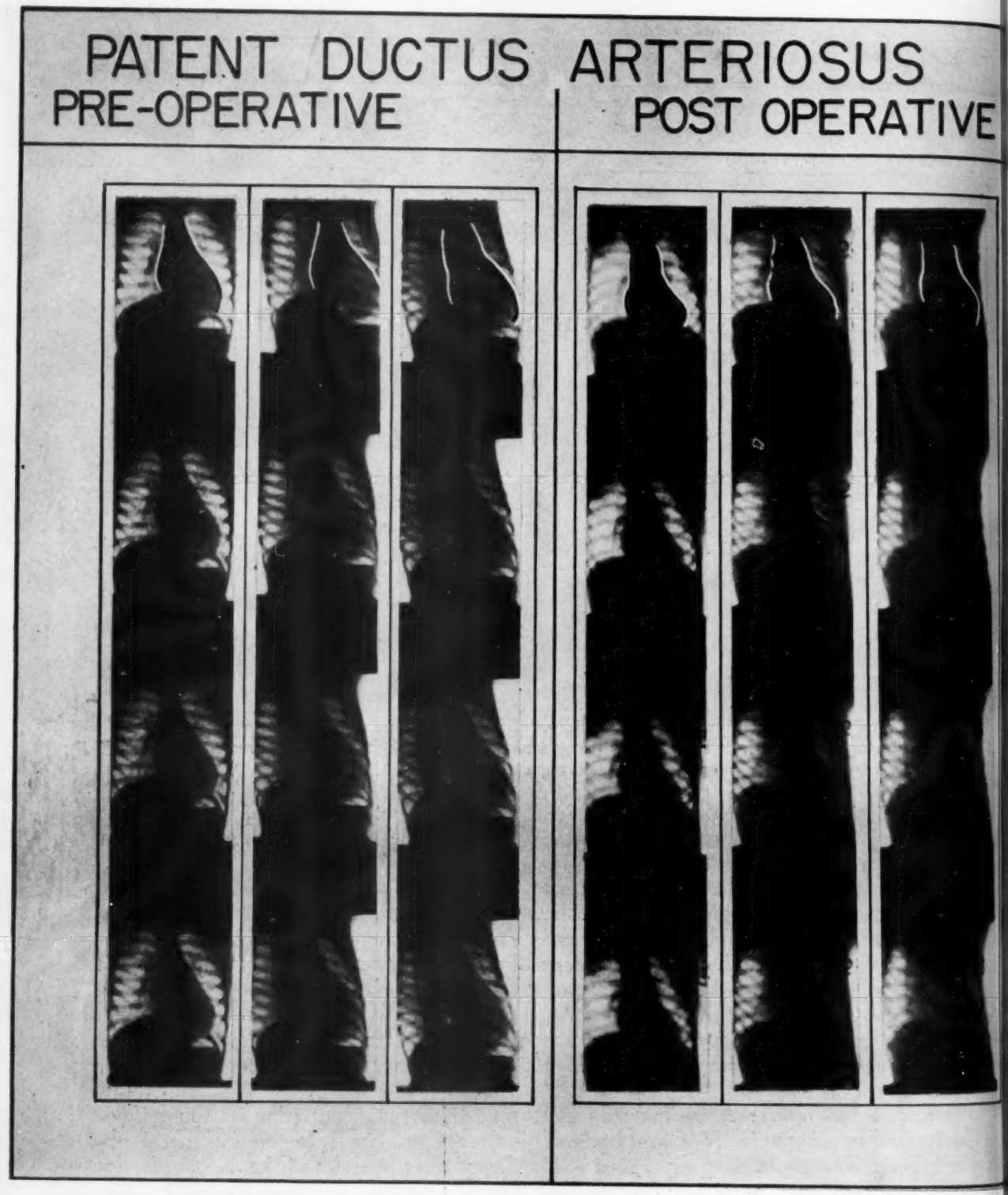

FIG. 3. Changes in the size and configuration of the cardiac silhouette, following correction of a patent ductus arteriosus, as viewed from various angles.

fluorographic examination (Fig. 2*D* and *E*). The image was effectively magnified by using the small supplementary fluorescent screen (Fig. 1*C*) directly in front of the camera. When a definitive diagnosis is made, this record will be useful in recalling the roentgenoscopic appearance at this early age.

The arterial blood pressure in a boy, aged seventeen, with coarctation of the aorta was 170/120 in the right arm and 140/100 in the left. Since a constriction of the aortic arch adjacent to the root of the carotid or subclavian arteries may be difficult to correct surgically, the aortic arch was visualized by cinefluorographic recording of a retrograde aortogram using the f 0.8 lens. Ten milliliters of 70 per cent diodrast was injected through a catheter secured in the left common carotid artery. During projection of the film it was noted that diodrast entered the ascending aorta, innominate artery and descending aorta, during diastole (upper two frames, Fig. 1*F*). During systole, the ascending aorta and innominate arteries were rapidly cleared of diodrast while the arterial tree beyond the origin of innominate artery remained well delineated. This was interpreted to mean that the aorta was obstructed between the innominate and left common carotid arteries (see arrow, Fig. 2*F*).

Persistence of the ductus arteriosus produced a definite cardiac enlargement in a girl, age six (Fig. 3*A*, *B*, *C*). The left border of the cardiac silhouette was straight in the posteroanterior view, but the pulmonary artery showed normal pulsation and was not prominent as when viewed from any aspect during rotation into the right anterior oblique position. Two months after the ductus arteriosus was interrupted, the size of the cardiac silhouette was strikingly reduced (Fig. 3*D*, *E*, *F*). In the films obtained postoperatively, the diaphragm was higher and the films had less contrast, obscuring the fact that the vascular markings in the peripheral lung fields were reduced after the surgical intervention.

Rotation of the patient during cinefluorography provides a three-dimensional orientation of structures within the thorax. A seven year old patient with a fusiform tumor within the chest was rotated from the posteroanterior position into the left anterior oblique position (Fig. 4*A*, *B*). During projection of the film, the mass rotated in the same direction and at the same angular velocity as the thoracic spine (Fig. 4*C*). It was obvious that the tumor was applied to the right lateral aspect of the vertebral bodies between the second and seventh thoracic vertebrae. Two weeks later, a sympathoblastoma was excised from the position described.

Differentiating intrathoracic tumors from aortic aneurysms is occasionally difficult. In one patient, a pulsating mass had eroded the proximal end of the clavicle and first rib. During rotation of the patient, the mass moved in a direction opposite to the displacement of the spine (Fig. 5*B*, *D*), and appeared to originate in the ascending aorta near the summit of the arch. Using the small fluorescent screen (Fig. 1*A*), a close-up view disclosed lateral movement of the aortic knob during each cardiac cycle (compare the upper and lower films in Fig. 4*C*). However, there was no obvious lateral movement or expansile pulsation of the tumor mass. This was confirmed by simple planimetric measurements. Postmortem examination revealed a large aneurysm which involved the innominate artery. The aneurysm was firmly attached to the anterior thoracic wall and the lumen was virtually filled with an organized thrombus.

The advantages of cinefluorographic angiocardiography is illustrated by the following case. An infant, considered normal at birth, entered the Children's Orthopedic Hospital at the age of one month because of severe cyanosis associated with crying. Roentgenoscopy and teleroentgenograms revealed massive generalized enlargement of the heart. The respiratory rate was 116, the heart rate was 152, the liver was down 1½ inches, but routine laboratory tests were negative. The femoral

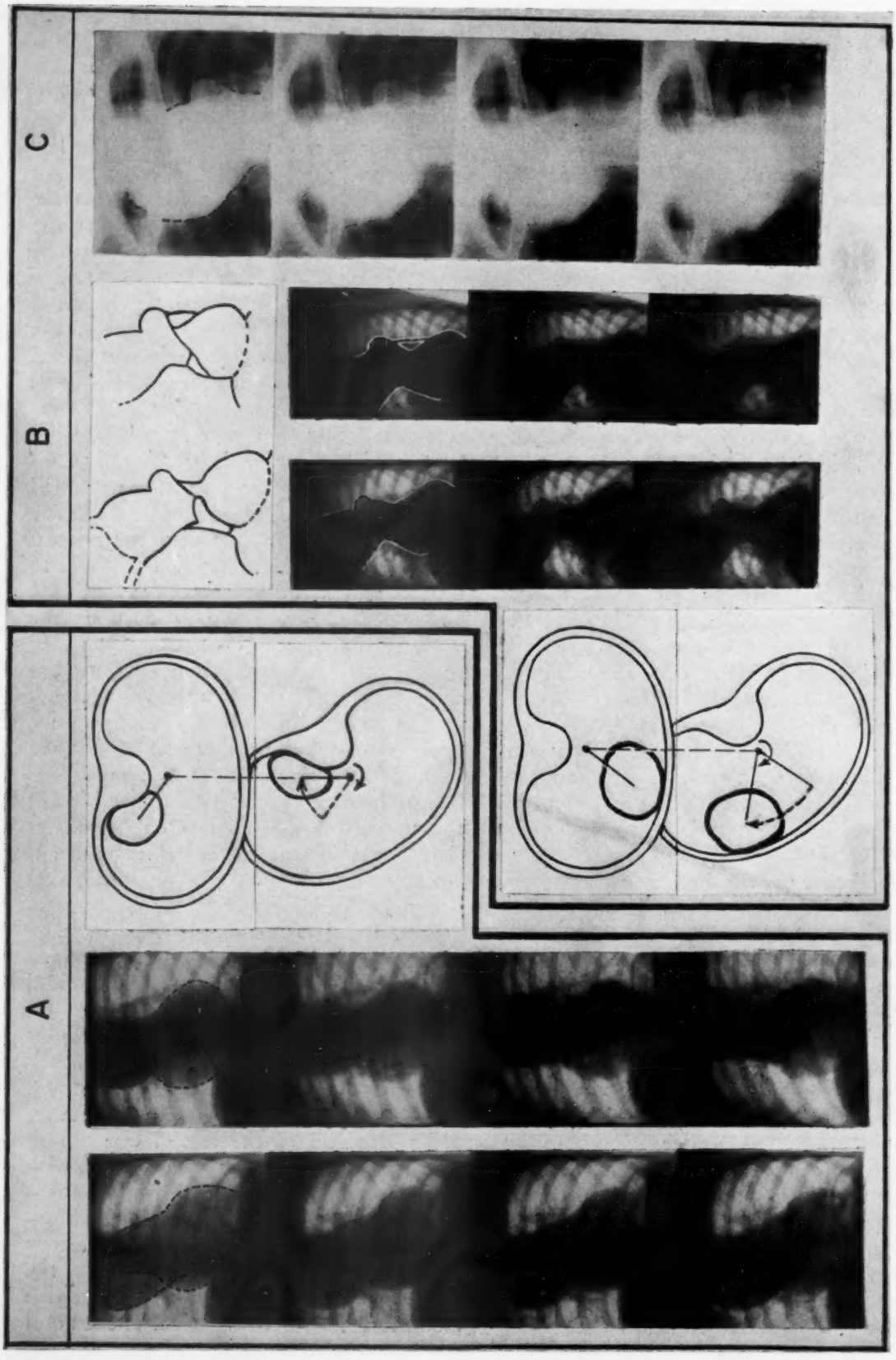

FIG. 4. Localization and differentiation of a mediastinal tumor. (*A*) Sympathoblastoma adherent to the right lateral aspect of the thoracic spine. (*B*) Aortic aneurysm involving the innominate artery.

pulses were absent and the blood pressure in the right arm was 240/80/0 and in the left, 200/80/0. An electrocardiogram was within normal limits with a mean electrical axis of +90°. The R and S waves were of equal amplitude in CF_5. The child responded so well to oxygen and digitoxin that, after a month, therapy was discontinued and he was discharged from the hospital in good condition. The parents insisted on surgical intervention, and, after extensive consultation, cinefluorographic angiocardiography was requested to visualize the aorta and to ascertain if the ductus arteriosus was open.

When the patient was eleven weeks old, cinefluorographic angiocardiography was carried out with the patient in the left anterior oblique position, 20 cc. of 70 per cent diodrast* being injected through polyethylene tubing secured in the exposed left jugular vein. Injection of diodrast should be completed in one or two seconds. In this case, the small caliber polyethylene tubing prolonged this period to four seconds to the detriment of the recorded images. With a film speed of 15 frames per second during the nine second exposure, a total of 144 pictures were obtained. During the first two seconds, the diodrast successively outlined the superior vena cava, right atrium, right ventricle and pulmonary artery (Fig. 6). The right ventricle obscured the right atrium except for the right auricular appendage (Fig. 5, *B-1*) which periodically projected beyond the right border (*D-1*, *E-1*, *2*, *F-1*, *2*). The right ventricular cavity and pulmonary artery appeared dilated. The ductus arteriosus was closed. The inferior vena cava and hepatic veins were repeatedly outlined by a retrograde flow of blood. At the end of this series, the left ventricle was just becoming outlined by diodrast returning from the lungs (Fig. 5 *H-4*). During the next four seconds both right and left sides of the heart were outlined by the contrast medium and this portion of the record has been omitted. In the final second of exposure (Fig. 6, *H-4*) the left ventricle and aortic artery are more clearly outlined as the right side of the heart cleared of diodrast. The left ventricular cavity was almost spherical and appeared dilated. The thick wall of the left ventricle was readily visible at the apex and extended from the cavity of the left ventricle beyond the left main pulmonary arterial branches. Considerable residual blood was present at all times in both ventricular cavities; indeed the reduction in area during systole was almost imperceptible (in Fig. 5 compare frames *E-4* and *F-1*; in Fig. 6 compare *E-1* with *E-2*). The aortic arch was narrow and almost hidden behind the bulbous pulmonary artery (Fig. 6, *C-1*).

Four and one-half seconds after sufficient contrast medium reached the left ventricle, the descending aorta became barely visible below the diaphragm (Fig. *6B*) and about eight seconds after the initial injection, the narrowed abdominal aortic shadow could be traced to the bottom of the frames (Fig. *6C*). The flow through the abdominal aorta was extremely slow. A much more dynamic picture of these events is afforded by projecting the film so that the progress of the contrast medium and the movements of the heart can be observed.

The following conclusions were drawn: The superior vena cava, inferior vena cava and hepatic veins were normal. (Retrograde filling of veins during diodrast injections have been routinely observed in experimental animals.) The right ventricle was enlarged and the pulmonary artery was dilated. The ductus arteriosus was closed. The left ventricle was hypertrophied concentrically and the arch of the aorta was narrow throughout its entire length. The principal obstruction appeared to be on the descending limb of the aortic arch at or near the site of ligamentum arteriosus, and the blood flow through the abdominal aorta was slow, indicating that collateral circulation was poorly developed.

The child, returned to bed in good condition, was discharged to home care after four days. Ten days later he suddenly developed respiratory distress and the cyanosis returned. Despite supportive treatment

* Generously supplied by The Winthrop Stearns Company.

spine. (*B*) Aortic aneurysm involving the innominate artery.

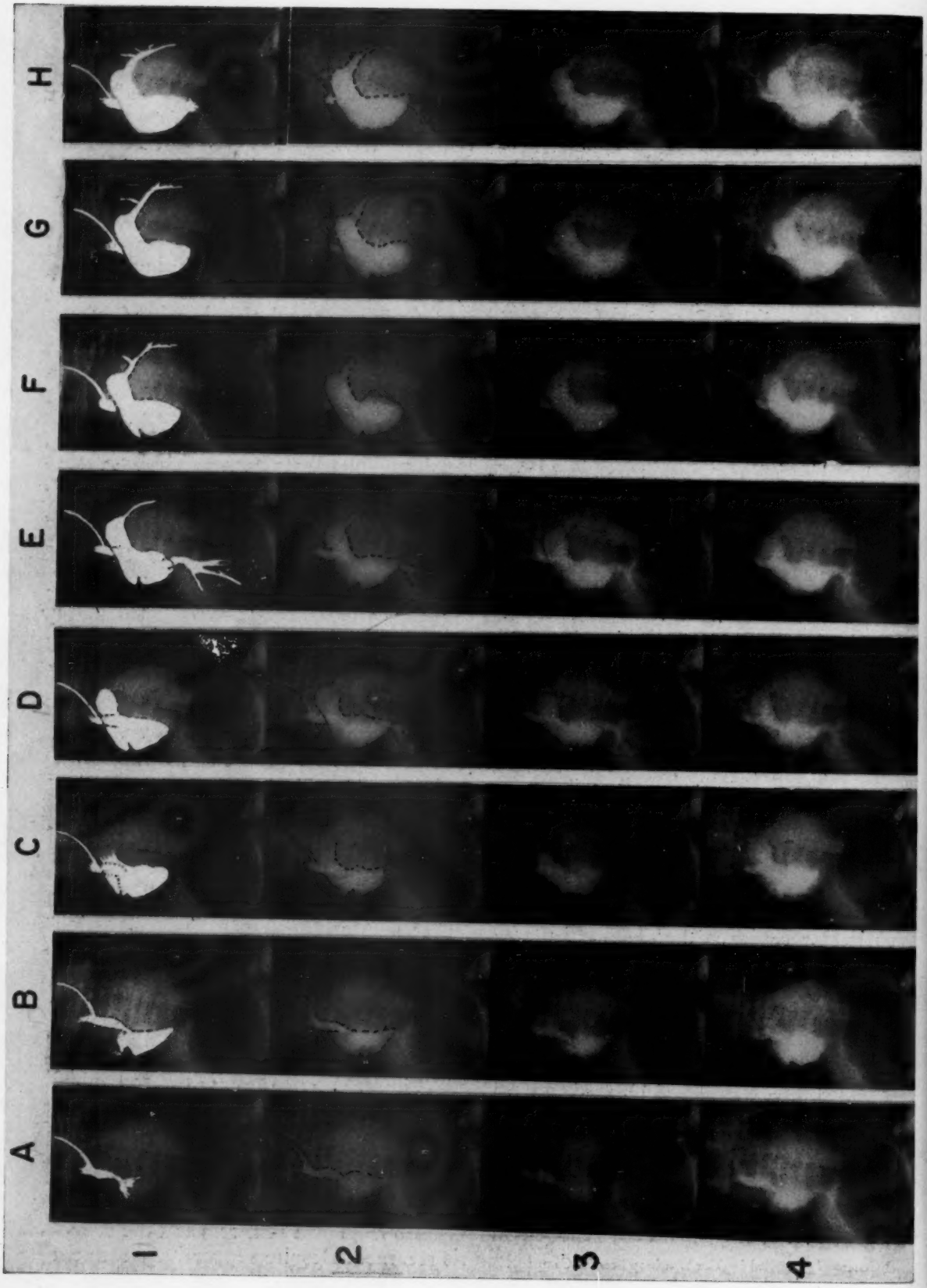

FIG. 5. Cinefluorographic angiocardiography for infantile coarctation of the aorta illustrating the first 2.1 seconds.

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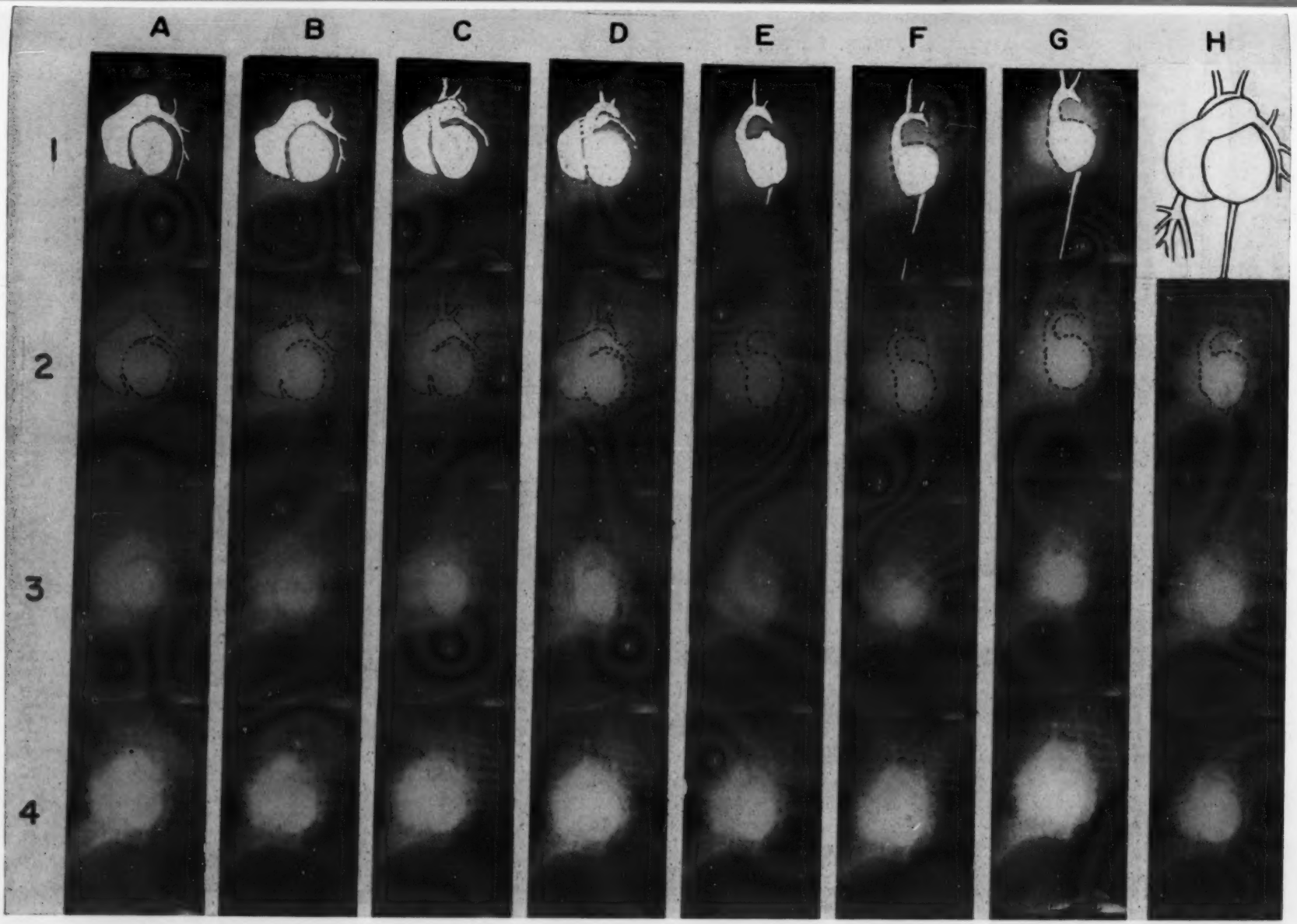

FIG. 6. Continuation of Figure 5 extending from 6.4 to 8.5 seconds after the entrance of the diodrast into the right atrium.

he died within sixteen hours. Postmortem examination confirmed the impression derived from the angiocardiogram in every detail except for a severe atelectasis, pulmonary edema and right hydrothorax, part of which may have developed terminally.

DISCUSSION

Projected cinefluorograms of the cardiac silhouette provide greater contrast and illumination than are available during routine roentgenoscopy. Due to variations in penetration and film processing, accentuation or diminution in the vascular markings in the lung fields cannot always be assessed with confidence. However, the films can be studied at length and reviewed periodically during extended case studies. No report of a roentgenoscopic examination can provide the information available in these films months or years after the original examination. The 20 roentgens required for cinefluorography compares favorably with the radiation used in routine roentgenoscopy (17 to 24 r per minute), except that the volume of tissue exposed may be considerably larger.

Simple cinefluorographic apparatus can be used with standard roentgen-ray equipment of sufficient capacity. The exposed film can be processed and prepared for projection within two hours. Repetitive printing by commercial concerns provides films which are valuable for record and study and as training aids.[10]

As an adjunct to routine roentgenography, the cinefluorographic technique has been useful as a permanent record of the roentgenoscopic appearance of the heart, differentiation and localization of mediastinal tumors, in retrograde aortography and angiocardiography. Pending considerable improvements in efficiency, the latter application will be limited to patients under the age of twelve years.

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BLASTOMYCOSIS AND ACTINOMYCOSIS OF THE SPINE

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THE most common granulomatous infection of the spine is tuberculosis, but there are two other such infections which occur that deserve comment. One, blastomycosis, mimics tuberculosis very closely, while the other, actinomycosis, usually produces a very different roentgen pattern.

Blastomycosis invariably produces abnormalities in the disc space and marked narrowing is the usual change. Also it produces changes in one or more spinal segments and vertebral body collapse is common. Bone destruction is predominant (Fig. 1) and there is little proliferative reaction for relatively long periods of time. As in tuberculosis, the infection spreads from segment to segment by dissecting under the spinal ligaments, especially anteriorly. Because of the latter mode of extension the disease frequently results in prominent concavities of the anterior vertebral borders, a finding so characteristic of tuberculous spondylitis. Also, this manner of spread accounts for the "skip" involvement of segments for the dissecting pus may by-pass one or more vertebrae only to involve others.

Rib destruction either by direct extension or by pressure erosion is a frequent finding. Here, again, there is a tendency for very slow bone proliferation and sclerosis.

Paravertebral infection almost always accompanies the bone disease and the roentgen picture is that of either a fusiform or globular shadow at single or multiple levels. The abscess may be unilateral, but most often is bilateral. In the lumbar region spread into the psoas area is common and is associated with the usual roentgen finding of psoas shadow bulging.

Clinically, there are no particular symptom differences between tuberculous and blastomycotic spinal axis disease. Since there is no distinctive difference in the roentgen findings, the diagnosis must rest upon demonstration of the causative organism or certain very important and distinctive immunological data. Smith[4] recently described the immunologic patterns that patients may exhibit and pointed out very signally the importance of these, both in establishing the diagnosis and determining the proper treatment. Improper use of iodides may prove hazardous, and roent-

FIG. 1. Blastomycosis of the spine and ribs. There is marked bone destruction. Also, a large paravertebral abscess is present.

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Fig. 2. Actinomycosis of the thoracic spine (primary type). This shows the soap-bubble pattern which is commonly seen.

gen therapy may be of no avail, yet when sensitive patients are properly desensitized, iodides plus roentgen therapy may prove curative. For detailed information, the reader is referred to the original article by Smith[4] and to the excellent manual on mycotic diseases by Conant and others.[1]

Actinomycosis produces different roentgen findings from those described above. When primary in the vertebra it produces an unusual change. The bone, when roentgenographed, has a soap-bubble appearance. The pattern is one of multiple small areas of rarefaction surrounded throughout by zones of normal or dense bone (Fig. 2). Collapse of the vertebral body is not particularly pronounced and there may be little change in the contour for long periods of time. Paravertebral soft tissue swelling is usually present, extending along the course of the involved segments and even beyond. Most often this is of a fusiform nature and not very conspicuous.

The peculiar soap-bubble type of change in the vertebra is, we believe, rather distinctive and, whenever encountered, the possibility of intrinsic or primary vertebral actinomycosis must be seriously considered. Other infections and neoplasms may at times present a similar roentgen appearance, but not very frequently.

We recently studied a case of actinomycosis which presented the pattern as outlined. Tumor was suspected, chiefly because of the absence of any systemic features commonly associated with infection. At operation a mass was encountered. There was no pus formation. Grossly, it was compatible with either a neoplasm or granuloma. The histopathological findings were that of granuloma, but no specific diagnosis was possible. After a period of time, the operative wound began to discharge purulent exudate from which actinomyces were cultured and found in direct smears. With treatment for the fungus infection the patient has made satisfactory progress.

Actinomycosis may, however, involve the spine and produce a totally different roentgen appearance than described above. As a consequence of intra-abdominal infection, the organism may eventually spread to the spine and involve it in an extrinsic or secondary manner. Thus, following actinomycotic appendicitis, the psoas may become involved and the infection spread to reach the lateral borders of the lumbar vertebrae. The changes produced are very distinctive.[2] The bone reaction is one of intense sclerosis. Dense, long spurs are formed and they usually run longitudinally, bridging the vertebrae. The spurs do not project very far laterally and thereby are somewhat different than those seen following trauma or localized pyogenic disease.

Another distinctive feature of this so-called extrinsic or secondary vertebral actinomycosis is the presence of dense, eburnizing bone changes that extend from the lateral vertebral border into the body itself. The sclerosis extends for variable

distances into the body, obliterating the fine trabecular pattern and replacing it with rather homogeneously dense bone (Fig. 3 and 4). Any element of bone destruction which may be present is completely overshadowed by the proliferative changes. Collapse of the involved vertebral bodies is infrequent. The disc spaces show moderate narrowing, but herniation of disc nuclei into the vertebral plates is unusual. Thus, it would seem that the infection does not in any way weaken the bodies and it may actually result in structural stability.

There is a very striking similarity in the clinical histories of the patients with secondary actinomycotic spondylitis. Yet, in spite of this, the diagnosis is often very elusive. The patient is usually a chronically ill, debilitated person who was previously operated upon and diagnosed as having either appendicitis or inoperable malignancy. In the former instance, the appendix is removed and the patient seems well only to show puzzling symptoms later on. Frequently, foreign body is suspected because of sinus tract formation. The latter

Fig. 3. Secondary actinomycosis of the lumbar spine. Note the dense spurs and the changes in the involved vertebral bodies.

Fig. 4. Another case of secondary actinomycosis of the spine.

cases show a nonsuppurative mass at operation and both grossly and histopathologically it simulates neoplasm. Again, some weeks or months following operation, abdominal wall fistulae may form.

Even with such a clinical group of symptoms and signs, the diagnosis is not necessarily easy to make. Drainage from the fistulae may not show the usual sulfur granules; indeed, in some cases, an acid-fast organism is recovered and an erroneous diagnosis of tuberculosis is made.

The roentgen study is almost always, in the complicated picture as described, of significance. Soft tissue changes such as obliteration of psoas shadows, renal outlines and peritoneal fat lines are frequent. These, however, are in no way diagnostic, so that when in a puzzling case the changes above are also accompanied by the vertebral densities previously described, a positive diagnosis can be rendered. The most recent case seen by us presented so typical a spine picture that a probable diagnosis of actinomycosis was made from the wet film. In a few minutes the sulfur granules were demonstrated in the scrapings from the

wall of an abdominal sinus tract.

The appearance of the spine is strikingly similar in each instance. It is this that helps to integrate the entire picture in each case.

Patients with secondary actinomycosis of the spine may have no evidence of significant symptoms of spinal axis disease. Thus, the roentgen survey directed at elucidation of some obscure intra-abdominal disease may, by virtue of distinctive spine changes, aid immeasurably in establishing a correct diagnosis.

Actinomyces bovis is the only form which infects man. According to Cope,[2] it is unable to penetrate through normal epithelial surfaces; it gains access into cellular tissues through breaks in skin or mucosal surfaces. A mass of avascular tissue forms and this may grow for years before eventually forming an abscess. Biopsy of such masses is often erroneously interpreted as neoplastic. Frequently, following such biopsy, abscess formation seems to be hastened. Such sequelae are often mistaken for secondary infection in a malignancy. Because of these aspects, the roentgen changes in the spine assume extreme importance, for, when present, they call for complete revaluation and may well lead to clarification of a puzzling problem.

A word of caution is proffered concerning the finding of actinomyces. The mere demonstration of the organism is not necessarily indicative that it is the causative agent of the disease. It must be proved that the organism is not merely present in the site of another disease process. Recently, actinomyces were demonstrated in pure culture in cases of Hodgkin's disease and brucellosis, but because of proof of the presence of these diseases and the absence of the expected concomitant changes of actinomycosis, the organisms were considered as not significant.[3] The presence of the spine changes described would prove of crucial importance in the evaluation of any suspected case.

Proper diagnosis leads, of course, to logical treatment. Before the advent of chemotherapy and antibiotics, radical surgery was imperative in abdominal cases. Adequate drainage was obligatory. Roentgen therapy was a valuable adjunct in the treatment. Now, with antibiotics, the necessity for extensive surgery may be obviated. The combination of limited surgery, antibiotics and roentgen therapy is relatively effective. Treatment, however, must be prolonged and intensive, if the patients are to be cured. Close cooperation among the consultants is often very rewarding and a patient who seemed hopelessly ill may often be restored to good health.

CONCLUSIONS

1. Blastomycosis of the spine simulates tuberculosis.

2. Actinomycosis produces two forms of spondylitis: (a) primary or intrinsic; (b) secondary or extrinsic. The first produces a soap-bubble appearance. The second results in long dense spurs and sclerotic changes in the lateral portions of the involved vertebrae.

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MOTION OF THE LUMBAR SPINE

A ROENTGENOLOGIC STUDY*

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SINCE Ernst Heinrich Weber studied spinal motion in three cadavers in 1827, the problem has been investigated by Volkmann, Guerin, Lohr, Hughes, Schulthess, Fick, Strasser, Virchow, Lovett, and Dittmar. More recently Bakke reported on a roentgen study of spinal motion ranges, and Lockhart, Fowler and Brailsford made cineroentgenograms of spinal movements.

Begg and Falconer have recently studied the possibility of diagnosing spinal pathology, especially the disc syndrome, by variations from a "normal" pattern of 16°, 15°, 14°, 12°, and 10°, of motion range at the lumboscaral joint and at each successive overlying joint in that order. They also dismissed the lateral bending range of the lumbar spine as insignificant. In both of these statements these observers were at variance with the earlier work of Bakke.

This study was undertaken primarily to investigate normal lumbar motion in both to-and-fro and lateral bending ranges. We hoped to investigate some related problems. Was there a characteristic roentgen motion range for the ill defined low back pain group? How frequently was lumbosacral motion absent on roentgen study? Did lumbosacral motion, like sacroiliac motion, decrease with age to the point of complete stability? What was the effect of age on motion? Would a motion pattern be more obvious in childhood than after degenerative changes appeared? Was the lateral bending range really insignificant? Was there a compensatory increase in motion in another interspace or in another plane when motion was decreased in one interspace or in one plane?

A few subjects were studied not only regarding *total* motion ranges but also as to motion during *portions* of the complete range. These results were not significant (the size of the segments approached the method's error). Investigation of the rotation range of the lumbar spine was not entirely satisfactory, since observations could not be exactly reproduced, nor ranges accurately measured.

MATERIAL AND METHOD

The subjects of this study were 10 children and 45 adults, chosen at random. Originally 50 adults were studied for lower lumbar spine motion range, but when the study was extended to include motion of the entire lumbar spine, 20 of the series of roentgenograms originally studied had to be discarded (because the entire lumbar spine had not been visualized). We therefore added 15 more adults to this series.

Since Bakke's series included almost exclusively subjects from twelve to thirty years of age, we studied children ranging two and one-half to thirteen, and adults over thirty-five. No subject with a suspected disc was included, nor was any subject studied while low back pain was present. Roentgenograms were taken in the recumbent position, both for to-and-fro motion and for lateral bending. The tube was centered over the fourth lumbar spine when possible, and almost all films were taken under our personal supervision. We attempted to obtain the greatest possible motion range for each subject.

We realized, as had Bakke, that the roentgen method of study was not entirely without error. When we checked our results by repeating the roentgenograms and measurements of several subjects, we were agreeably surprised, however, to find that the results of these repeated observations usually agreed within 2°. We felt, therefore, that the accuracy of the method was sufficient for our purpose.

We obtained our measurements according to the method suggested by Begg and Falconer. "An accurate and rapid method of doing this is as follows: The film taken in extension is placed on a horizontal viewing box, and a sheet of paper is laid over its upper portion and held

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Table I

SUMMARY OF OBSERVATIONS—MOTION OF THE LUMBAR SPINE

Subject	Age	Sex	To-and-Fro Motion in Degrees					Lateral Bending Motion in Degrees					Pain		Roentgen Abnormalities
			L_5–S_1	L_4–L_5	L_3–L_4	L_2–L_3	L_1–L_2	L_5–S_1	L_4–L_5	L_3–L_4	L_2–L_3	L_1–L_2	Yes	No	n (normal)
	2	f	31	18	18	14	19	8	13	22	13	17		x	n
	3	m	35	12	14	15	8	10	18	13	6	4		x	n
	4	m	28	17	14	8	8	9	10	11	13	13		x	n
	4	f	19	14	11	12	5	6	8	10	11	16		x	n
	5	m	14	21	13	12	10	5	20	13	12	8		x	n
	6	f	18	19	14	17	15	8	11	11	11	12		x	n
	9	m	22	16	14	14	10	5	16	21	13	12		x	n
	10	m	23	18	17	13	8	5	10	20	6	9		x	n
	11	m	19	18	14	9	11	5	18	20	18	14		x	n
	13	f	33	14	19	17	10	10	21	17	14	11		x	n
A.C.	35	m	16	8	7	6	13	8	10	8	6	6		x	n
C.M.	37	f	10	15	17	10	6	4	10	13	11	10	x		n
I.L.	40	m	12	13	6	7	5	0	5	5	7	6	x		Spina bifida—L_5
J.W.	42	f	0	19	8	8	3	0	19	12	8	7	x		n
W.H.	44	m	10	16	7	12	0	4	11	9	5	5		x	n
G.R.	45	f	12	8	10	5	3	6	6	5	0	5		x	Osteoporosis (severe)
B.P.	45	f	0	2	7	5	5	0	5	14	9	3		x	n
S.E.	46	f	15	17	12	12	4	5	12	6	10	8		x	n
E.N.	46	f	0	10	7	8	9	0	8	7	7	2	x		Narrow L_5–S_1 space
L.G.	47	f	8	9	8	5	5	5	8	5	12	6		x	n
M.L.	47	m	12	5	3	7	0	0	0	0	10	0		x	Scoliosis
C.F.	48	f	7	22	11	8	9	0	5	15	8	7		x	n
A.G.	49	f	13	10	10	8	12	0	11	6	4	7		x	n
R.B.	49	f	0	16	7	5	5	0	5	7	12	3		x	Narrow L_5–S_1 space
D.C.	50	f	5	3	0	0	0	3	6	10	7	7	x		n
R.F.	50	f	11	7	8	3	6	0	5	8	6	7	x		n
R.F.	51	f	0	15	15	6	8	0	4	9	9	6	x		Sacralized L-5
R.L.	51	f	13	13	11	12	1	0	10	8	4	7		x	n
J.S.	52	f	0	4	0	8	0	0	7	6	10	5		x	n
I.Z.	52	f	12	12	9	3	0	2	3	8	10	7		x	n
A.L.	53	m	4	16	12	5	0	0	5	7	0	5	x		n
I.H.	54	m	10	13	17	12	8	0	10	8	4	7		x	n
M.K.	54	f	6	4	9	4	0	0	3	7	5	5	x		n
L.L.	55	m	13	0	6	9	4	0	9	3	5	6		x	Osteoporosis (mild)
M.P.	56	f	0	5	8	7	0	6	7	10	10	0		x	n
C.E.	56	f	4	10	10	5	6	0	9	10	7	3		x	n
S.S.	57	f	8	7	5	0	2	0	4	5	2	7		x	n
L.J.	57	f	0	0	0	5	2	0	0	8	4	5		x	Sacralized L_5
A.K.	58	f	11	13	13	0	8	0	7	8	2	9	x		n
M.M.	58	f	10	10	10	4	3	0	5	5	8	10		x	n
Y.R.	59	f	12	0	4	0	3	0	7	7	7	3	x		Osteoporosis (mod.)
G.K.	59	f	8	9	10	4	10	0	8	8	11	5	x		Slight spurring L_5, L_4, L_3
I.G.	60	m	10	10	10	5	7	0	9	6	6	5		x	n
F.S.	61	f	17	5	3	7	5	0	8	8	0	3		x	n
E.L.	62	m	5	6	6	8	3	4	14	7	5	3	x		n
M.B.	63	f	12	13	13	4	9	3	9	9	5	9	x		Osteoporosis (severe)
H.B.	65	f	0	12	5	14	0	0	8	9	13	8	x		Narrow L_5–S_1 space
L.V.	66	f	5	2	0	0	0	0	0	3	4	6		x	n
G.F.	67	f	13	8	3	10	0	0	7	5	7	5		x	n
J.P.	68	m	10	6	4	5	5	0	9	7	10	3		x	n
S.C.	68	f	15	12	0	0	0	3	3	3	1	3		x	n
E.F.	69	f	11	7	0	3	6	0	4	7	7	3		x	n
F.B.	70	f	0	5	5	3	0	0	9	7	7	3	x		n
W.M.	72	m	10	7	10	5	6	0	3	8	6	3		x	Narrow L_5–S_1 space
F.S.	77	f	0	5	3	3	3	0	6	6	6	3		x	Sacralized L_5

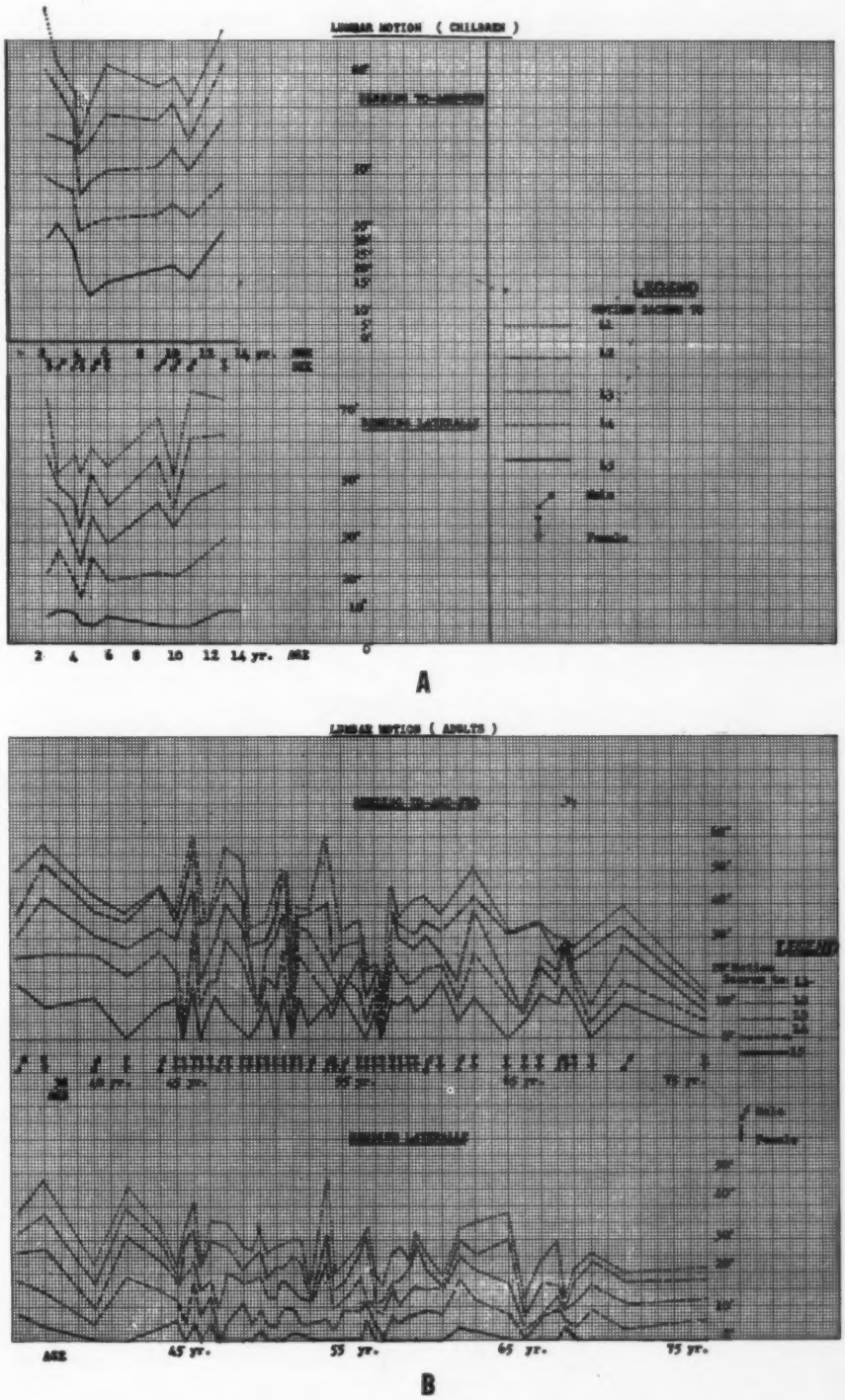


Fig. 1, (*A*) (*B*). Graphs of lumbar motion at various ages, and in each plane. The lowermost line represents fifth lumbar interspace motion range; the next overlying line has been plotted so that the difference between it and the lowermost line represents fourth interspace motion; and so on.

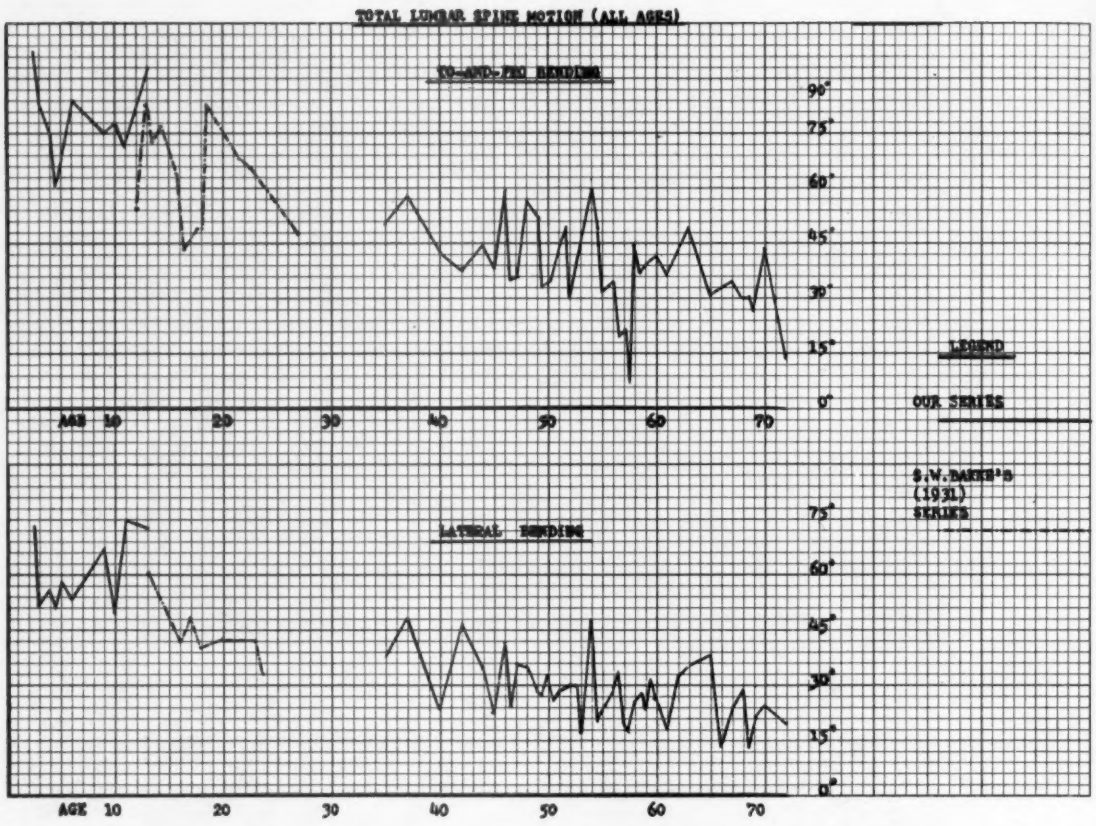


FIG. 2. Graphs of total lumbar motion at various ages and in each plane (Bakke's data shown also).

TABLE II

MOTION RANGES—AVERAGES AND STANDARD DEVIATIONS

Age		To- and- Fro Bending Motion Range					Lateral Bending Motion Range				
		L5–S1	L4–L5	L3–L4	L2–L3	L1–L2	L5–S1	L4–L5	L3–L4	L2–L3	L1–L2
2–13 (10 cases)	Mean	24.2°	16.7°	14.8°	13.1°	10.4°	7.1°	14.5°	15.8°	11.7°	11.6°
	S.D.	6.8°	2.6°	2.3°	2.8°	3.8°	2.0°	4.4°	4.4°	3.4°	3.7°
	σ^2/n	45.7°	6.6°	5.3°	8.1°	14.3°	4.1°	19.4°	19.7°	11.6°	13.5°
34–49 (14 cases)	Mean	8.2°	12.2°	8.6°	7.6°	5.6°	2.3°	8.2°	8.0°	7.8°	5.4°
	S.D.	5.7°	5.4°	3.2°	2.3°	3.8°	2.8°	4.4°	4.1°	3.2°	2.5°
	σ^2/n	32.1	29.5°	10.3°	5.4°	14.3°	7.8°	19.0°	16.4°	10.3°	6.4°
50–64 (22 cases)	Mean	7.8°	8.0°	8.1°	5.0°	3.9°	0.9°	6.8°	7.5°	5.8°	5.6°
	S.D.	4.8°	4.8°	4.6°	3.4°	3.3°	1.6°	3.0°	1.7°	3.1°	2.3°
	σ^2/n	23.5°	23.4°	21.5°	11.5°	11.0°	2.7°	8.9°	2.9°	9.4°	5.3°
65–77 (9 cases)	Mean	7.1°	7.1°	3.3°	4.8°	2.2°	0.3°	5 4°	6.1°	6.8°	4.1°
	S.D.	5.6°	3.1°	3.1°	4.3°	2.6°	0.9°	3.0°	2.0°	3.2°	1.7°
	σ^2/n	31.7°	9.4°	9.4°	18.6°	6.8°	0.9°	8.7°	3.9°	10.1°	3.0°

firmly in this position with a paper weight or similar object. Next the film taken in flexion is placed on top so that the outlines of the sacrum coincide in both films. and a pencil is drawn along the top margin of the upper film to form a baseline on the sheet of paper. Then the upper film is adjusted so that the shadows of the fifth lumbar vertebrae become superimposed and the pencil is again drawn along the top of the film. The process is repeated with the other vertebral bodies. The angles between successive lines indicate the amount of movement taking place at each interspace."

We employed this same technique for analysis of motion in lateral bending to the right and left.

TABLE III

ABSENT LUMBOSACRAL MOTION

Subject	Age	Roentgen Changes	Pain	Motion			
				L4–L5 To- and-Fro	L4–L5 Lateral Bending	Lumbar Spine To- and-Fro	Lumbar Spine Lateral Bending
R.F.	51	Sacralized L5	Severe frequent	15	4	44	28
L.J.	57	Sacralized L5	Mild rare	0	0	7	17
F.S.	77	Sacralized L5	None	5	6	14	21
E.N.	46	Very narrow L5–S1	Severe frequent	10	8	34	24
R.B.	49	Very narrow L5–S1	None	16	5	33	27
H.B.	65	Very narrow L5–S1	Moderate frequent	12	8	31	38
B.P.	45	Very slight lumbosacral lipping	Mild rare	2	5	10	31
J.W.	42	Normal	Moderate frequent	19	19	38	46
J.S.	52	Normal	Mild rare	4	7	12	30

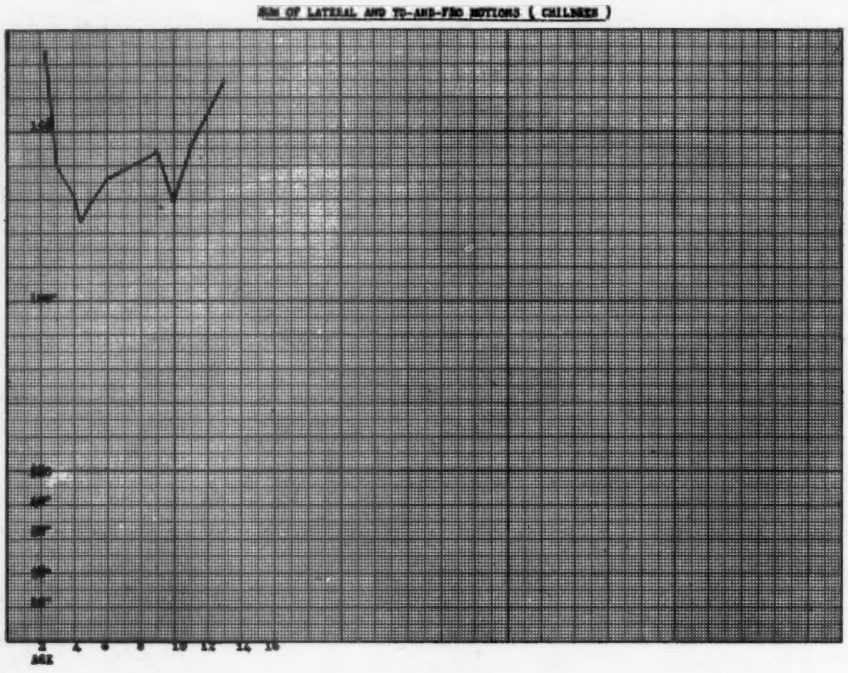
FINDINGS

A. General. Because of the very large individual variations in normal lumbar spinal motion, we have failed to obtain a "normal" pattern from which deviations may be called abnormal. Bakke also had found considerable individual variation, and while his observations on to-and-fro motion were consistent with our findings, his data on lateral bending showed a somewhat smaller motion range than ours.

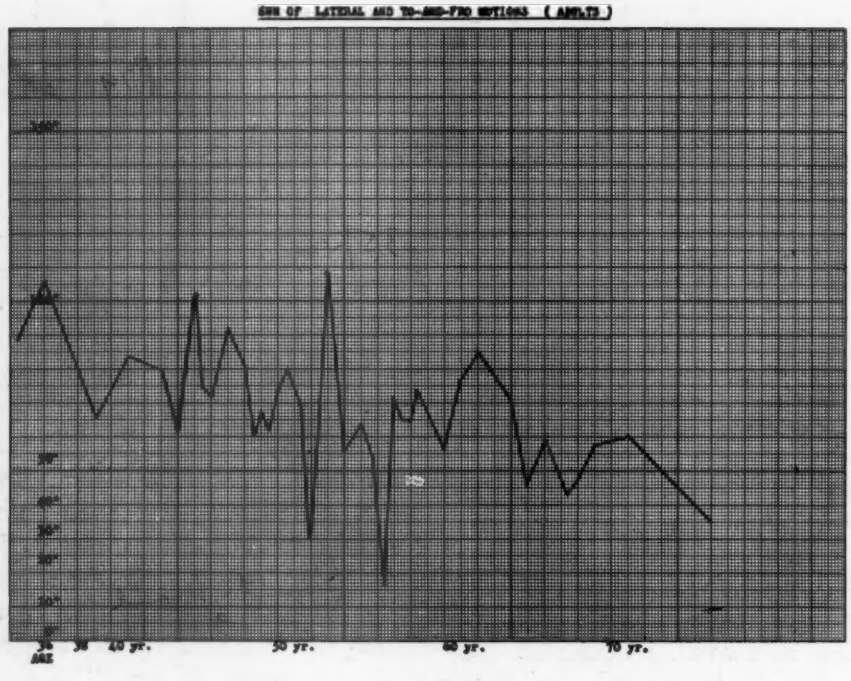
B. Lateral Bending Motion. In contrast to the assertion of Begg and Falconer that this motion is insignificant, we found the lateral bending motion range to average two-thirds as large as that of to-and-fro motion.

C. Rotary Motion. In contrast to Steindler's statement: "Rotation in the lumbar spine is almost negligible except for a few degrees of rotation between the fifth lumbar and the sacrum," we have found a definite and not negligible rotation range for the entire lumbar spine, in several subjects. As mentioned above, we were unable to accurately measure this range of motion.

D. Age, Sex, Weight. Increase in age was associated with a decrease in both to-and-fro and lateral bending motions. The average motion ranges of various age groups indicated that most of the motion loss during life occurred between thirteen and thirty-five years of age. The decrease in motion between the two and thirteen year group and the fifty and seventy-seven year groups approached statistical significance. Sex and body weight had no obvious effect on motion ranges.



A



B

FIG. 3, (*A*) (*B*). Graphs of total lumbar motion at various ages.

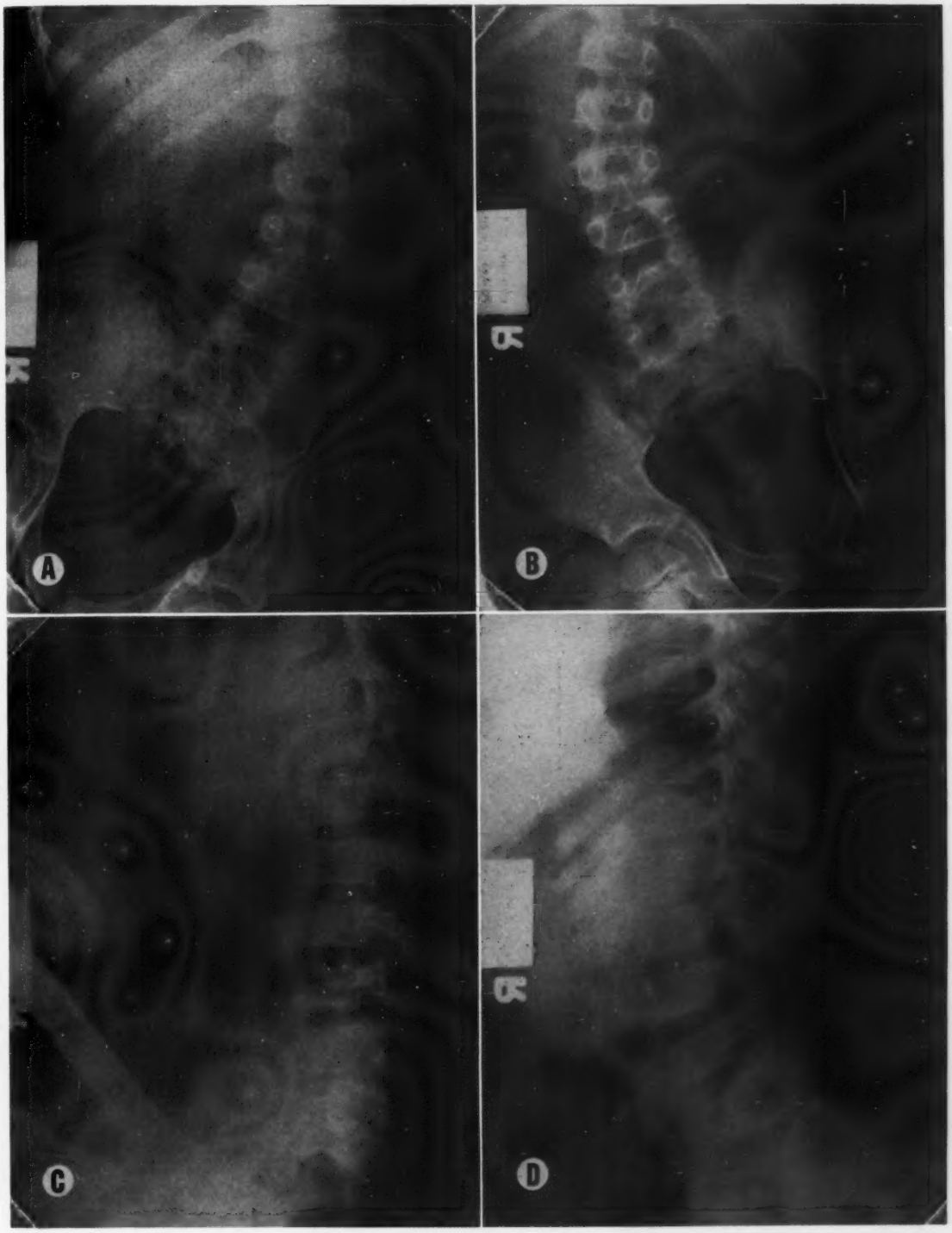


FIG. 4, (*A*) (*B*) (*C*) (*D*). Roentgenograms showing lumbar motion range in a child.

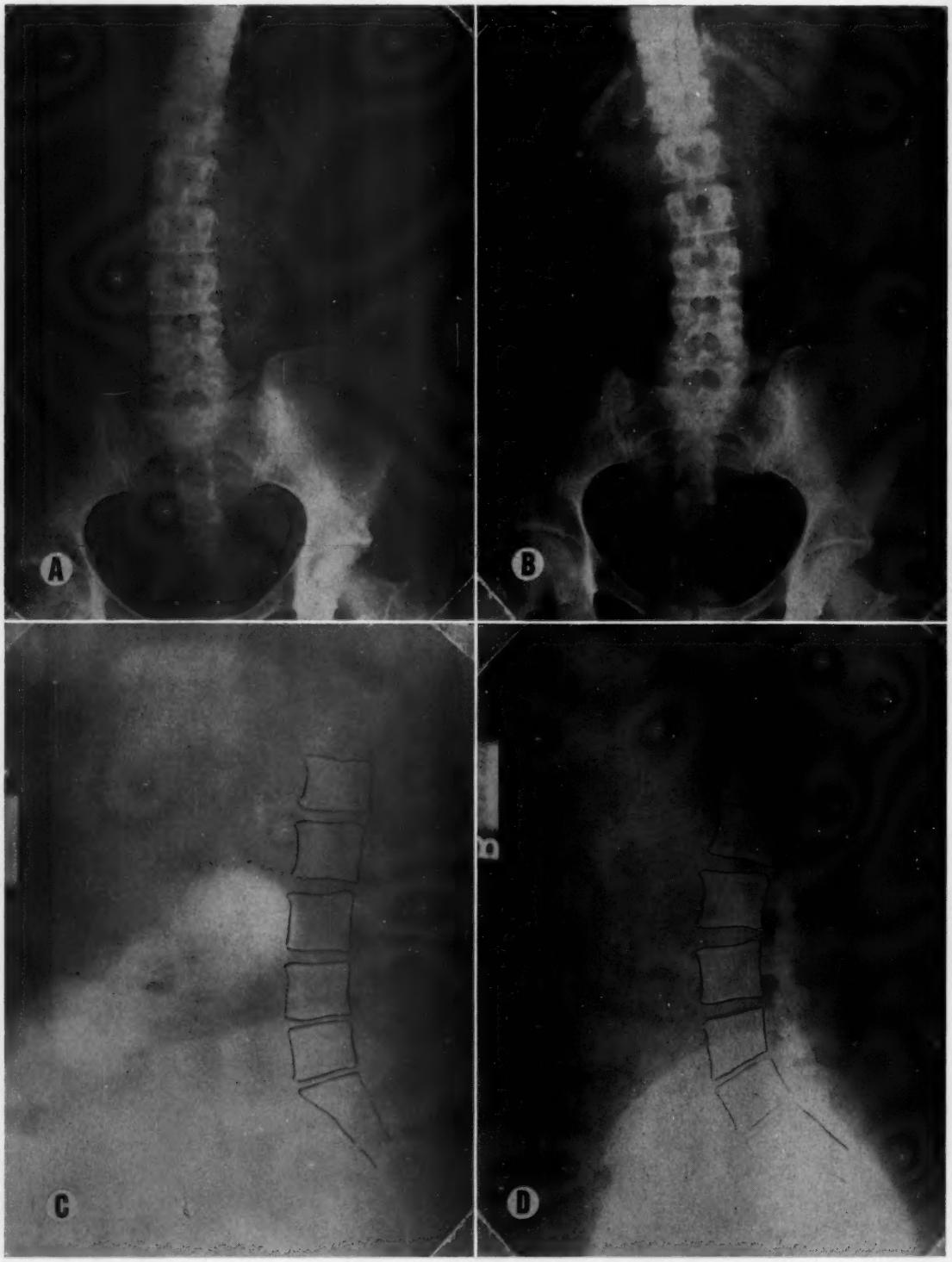


Fig. 5, (*A*) (*B*) (*C*) (*D*). Roentgenograms of a forty-eight year old female, not included in this series because of the back pain at the time of roentgenography. Notable is the marked narrowing of both the fourth and fifth lumbar interspaces, with absent motion at the fifth, but good motion at the fourth interspace. Compare with Figure 4.

E. Motion at Each Interspace. (a) To-and-Fro Motion. Comparison of the motion ranges at each individual interspace revealed that the average to-and-fro motion range in children was greatest at the fifth lumbar interspace. The slight decrease in average motion at each overlying interspace was not statistically significant. Although both the pattern and size of these ranges, on the average, agreed rather closely with the "normal" described by Begg and Falconer, individual variations were so large as to make the "normal" useless as a criterion. In adults, to-and-fro motion was usually slightly greater at the fourth interspace than at the others, with the order of decreasing average range the lumbosacral, the third, the second, and then the first lumbar interspaces. The differences were not statistically significant in view of the large variations, and do not conform to the "normal" of Begg and Falconer.

(b) Lateral Bending Motion. Motion at the fifth lumbar interspace was considerably less than that at any other interspace. This approached statistical significance, and was present in childhood as well as in later life.

F. Low Back Pain. The presence or absence of a history of incapacitating low back pain had no definite effect on lumbar motion at the upper four interspaces, and a very slight, not significant, decrease in the average lumbosacral motion range in both planes, in subjects with low back pain histories.

G. Absent Lumbosacral Motion. In 9 of 45 adults no lumbosacral motion was evident on roentgen examination, (our original series of 50 adults had shown a slightly higher percentage). Of 9 subjects, there

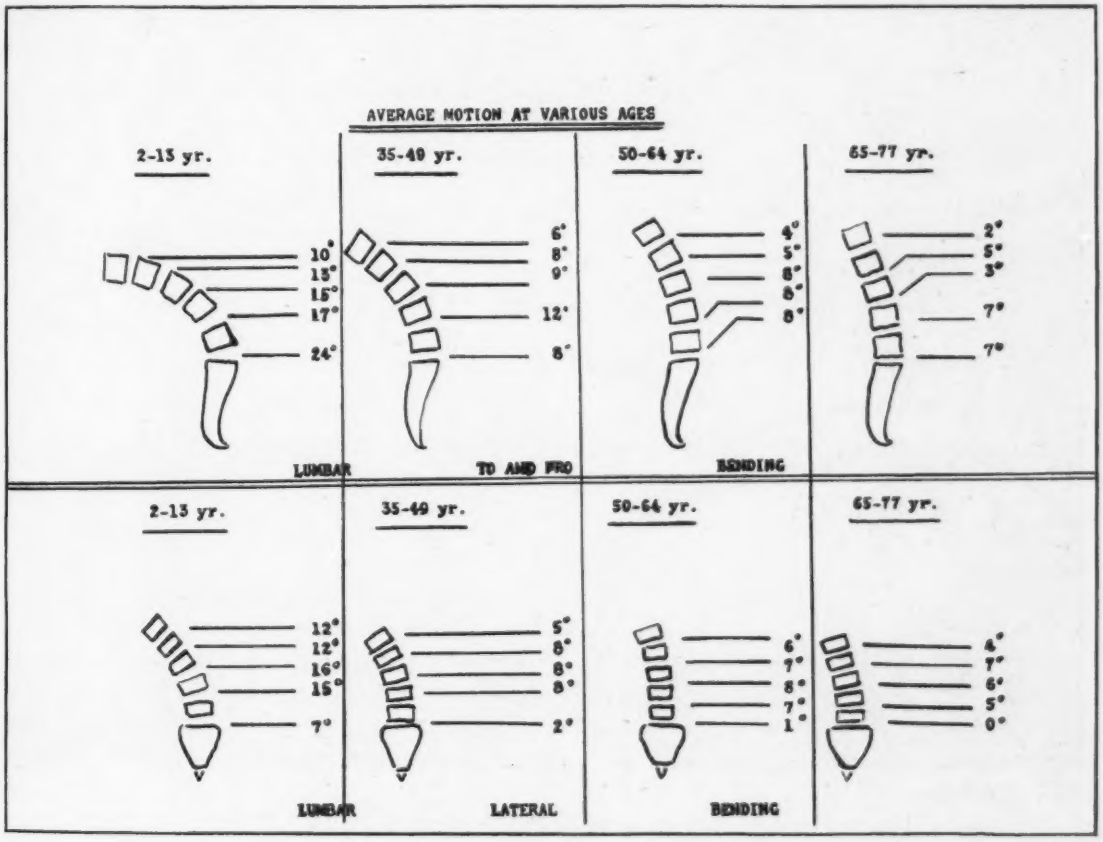


Fig. 6. Average motion at various age intervals.

were 3 with sacralized fifth lumbar vertebrae (1 showing no motion at the fourth interspace as well); there were 3 subjects with extreme narrowing of the lumbosacral disc; and there was 1 subject with very slight osteoarthritic lipping of the lumbosacral joint margins. There were 2 subjects with no roentgenographic abnormalities.

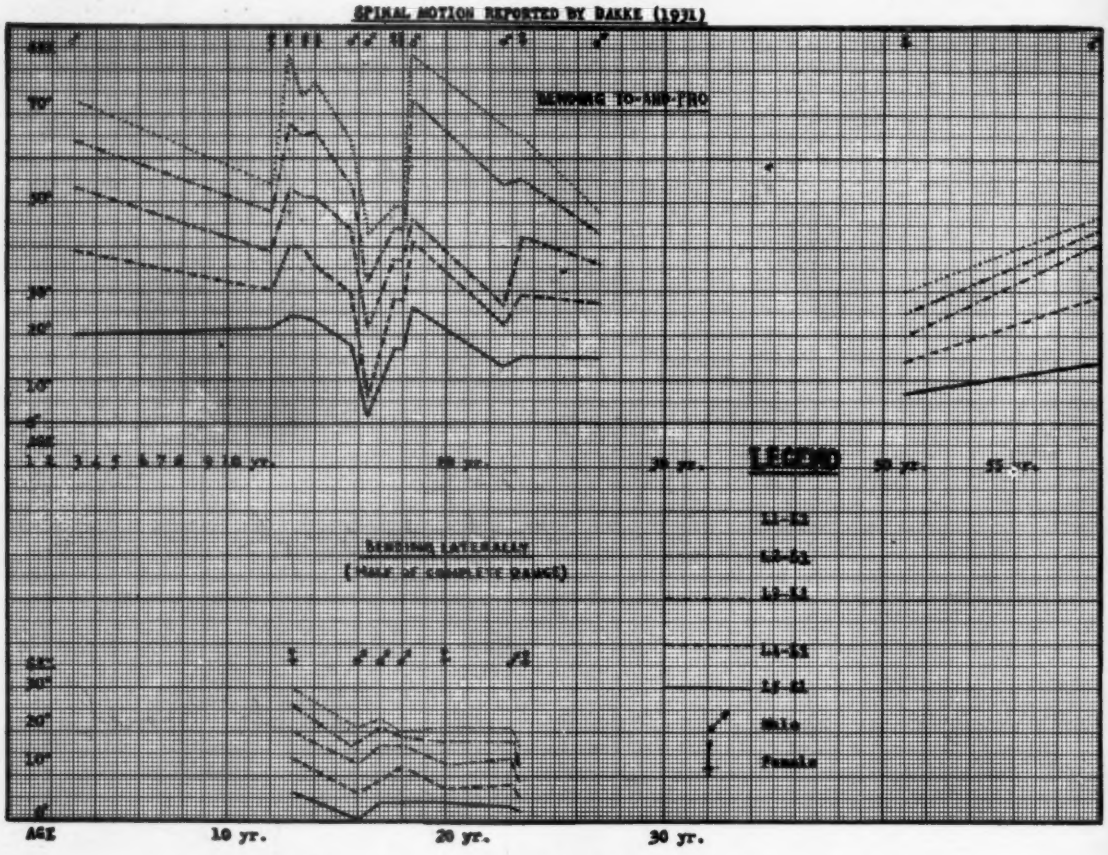


Fig. 7. Graph of data compiled by Bakke (1931). Compare with Figure 1.

There was no significant difference in these subjects, as contrasted with the general population studied, in age or in incidence of low back pain. There was no compensatory increase in motion of either the overlying space or of the lumbar spine.

H. Compensatory Motion. A subject showing a small motion range in one plane tended to exhibit no compensatory increase in range in the other plane. Similarly, a small range of motion at one interspace was usually not associated with an increase in motion at the other interspaces. Since the sum of the to-and-fro and lateral bending motions show an even greater variation than motions at individual spaces, it was evident that a spine with little motion in one plane or at one interspace actually tended to be associated with decrease in motion in the other plane or interspaces. Spines tended to "stiffen all over."

I. Miscellaneous. Superimposed films demonstrated that the center of motion in to-and-fro bending was anterior to the articular facets, and in lateral bending was medial to these joints. As Steindler has said, "The motion executed in the vertebral articulation is always a gliding and never a hinge motion because the center of motion lies outside the facets."

Another point of interest was that lateral bending was frequently not associated with rotation, contrary to Lovett's classical findings (in the cadaver this may be otherwise).

DISCUSSION

We have not been able to establish normal patterns of lumbar spinal motion within narrow limits because of the large individual variations. These variations have invited speculation.

Children exhibit varying motion ranges in many of the body's joints, attributed usually to differences in laxity of joint capsules, muscular development, and other soft tissue structures. In adults, differences in motion ranges are usually considered due to senescent changes in periarticular and bony tissues. It would seem that similar factors probably operate to produce the spinal motion variations that were so evident in this study. Our finding that most of the decrease in lumbar motion with advancing age had occurred by thirty-five years was consistent with findings of early degenerative changes in adolescence in other joints (*e.g.*, fibrillation of the articular cartilage of the knee).

The unexpectedly high incidence of absent lumbosacral motion on roentgen examination suggests the advisability of preoperative lumbar motion films for the proper estimation of the success of lumbosacral fusion. The greater success of fusion at the lumbosacral than at other levels would seem probably to be related to the very small lateral bending range at this level. Since at the lumbosacral joint normally there would be much less lateral bending motion than to-and-fro motion, in fusions at this level it might be conjectured that avoidance of to-and-fro motion postoperatively would be of the greatest importance.

If sacralized fifth lumbar vertebrae are excluded, there would seem to be no evidence to indicate that a mobile lumbosacral joint will not retain mobility, although diminished, throughout life, unlike the sacroiliac joint.

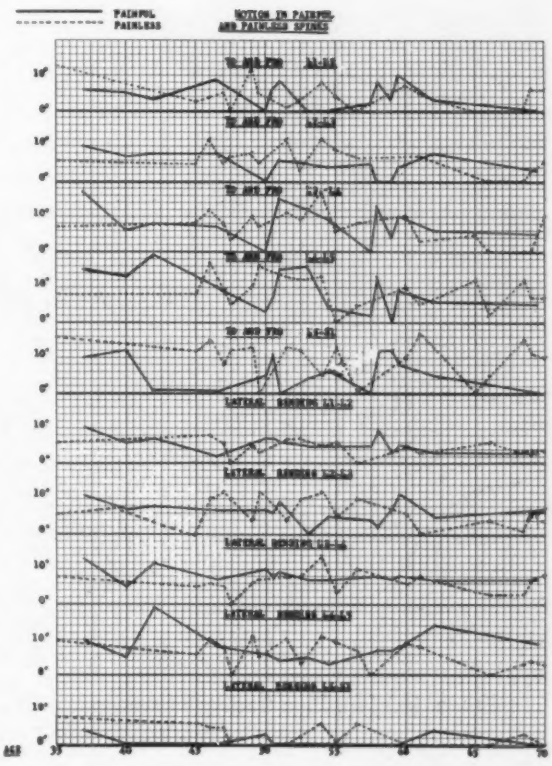


Fig. 8. Graphs comparing motion ranges in backs with and without history of pain.

CONCLUSIONS

1. A study of to-and-fro and lateral bending lumbar spinal motion in ten children and forty-five adults revealed marked individual variations. Rotation range in a few subjects, although not measured exactly, was not "almost negligible."

2. The motion range averages at various levels did not differ significantly, except for lateral bending and the lumbosacral joint. This latter was appreciably smaller than the other motion ranges.

3. Motion range averages at various ages revealed a significant decrease in adolescence and young adulthood. The motion loss after the age of thirty-five was not significant.

4. Subjects with a history of low back

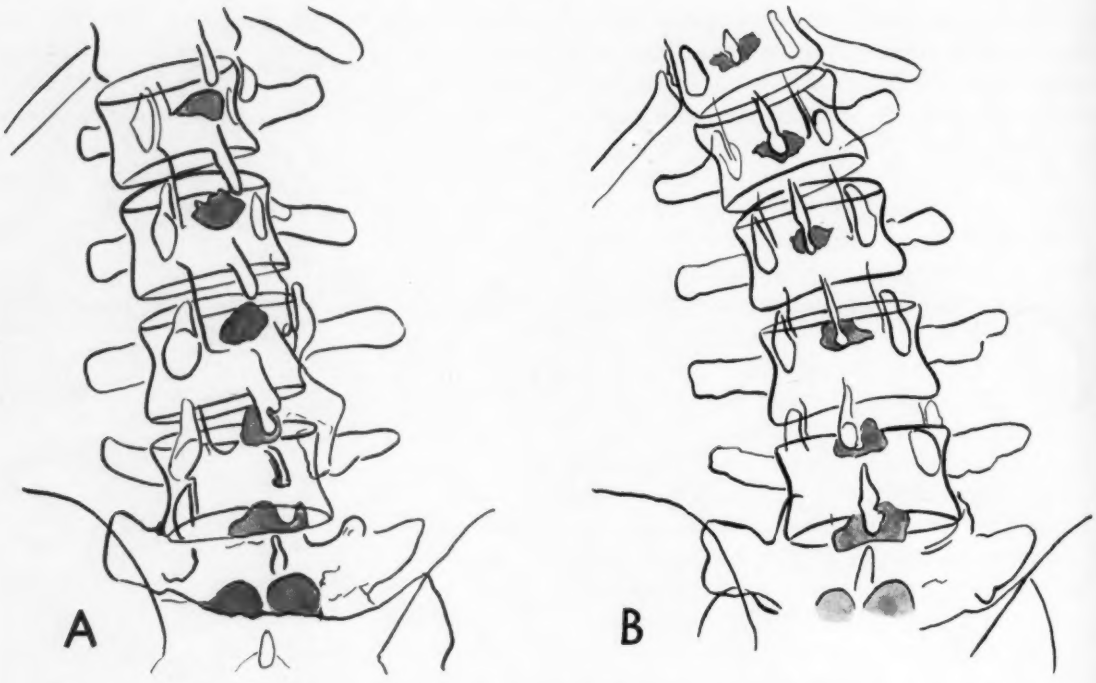


Fig. 9, (*A*) (*B*). Line tracings of roentgenograms showing (*A*) good rotation range, and (*B*) lateral bending without rotation in one subject.

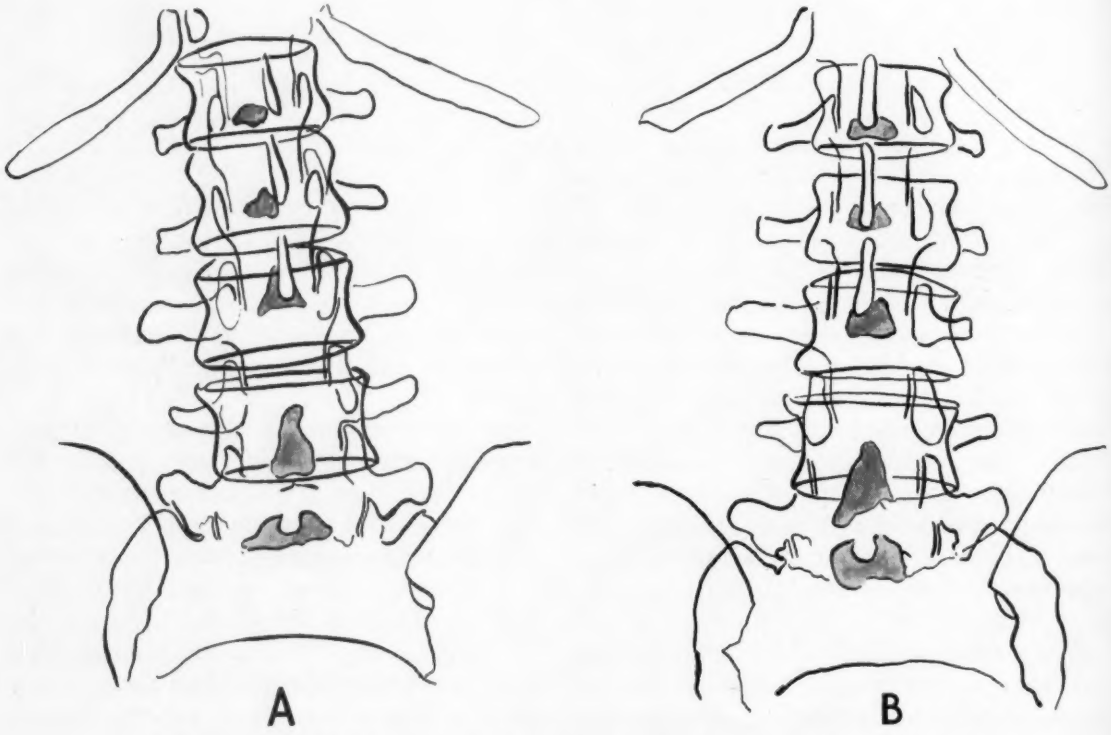


Fig. 10, (*A*) (*B*). Line tracings of roentgenograms showing rotation without lateral bending in another subject.

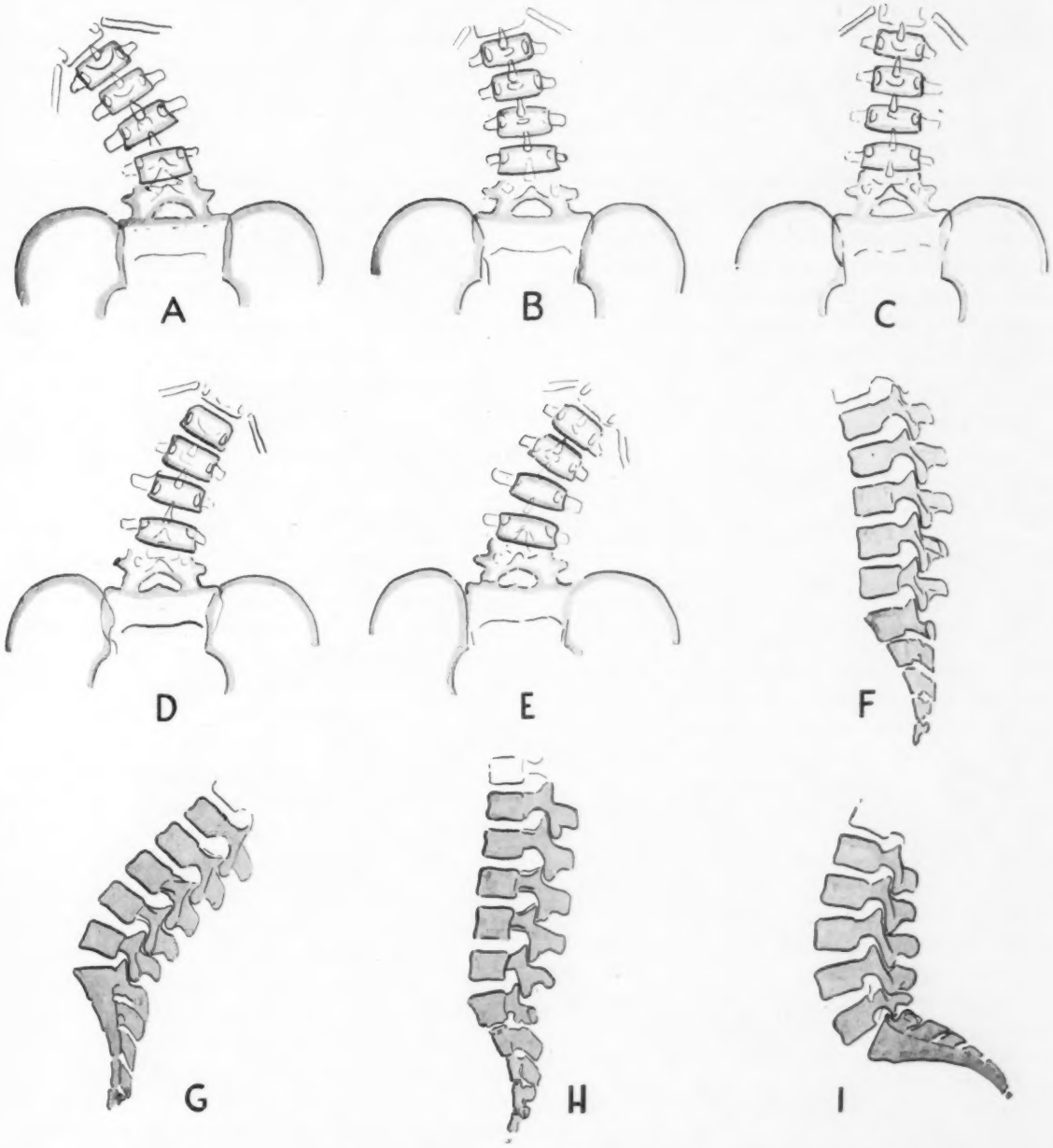


Fig. 11, (*A*) to (*I*). Line tracings of roentgenograms of a child showing segments of complete motion ranges in each plane. Although these segments were too small for accurate measurements, it appeared that most of the lumbar lateral bending motion occurred at the onset of total body lateral bending rather than the terminal portion, and that most of the to-and-fro lumbar range occurred in extension beyond neutral.

pain revealed no difference in the lumbar motion ranges as compared with pain-free individuals (except for decrease in lumbosacral motion averages, too small to be significant).

5. When a diminished motion range was noted at one level, a compensatory increase at another level was usually not present. Absent lumbosacral motion was observed in nine of forty-five adults. This was usually associated with fifth lumbar sacralization or with lumbosacral interspace narrowing. Unlike the sacroiliac joint, there was no evidence of spontaneous lumbosacral fusion with advancing age.

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THE ROENTGEN MANIFESTATIONS OF UNRECOGNIZED SKELETAL TRAUMA IN INFANTS*

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PERHAPS no body system of infants has been studied more intensively by the roentgen technique than the skeletal system. It is surprising, therefore, that physical trauma, probably the most common bone "disease" of infancy, should have certain roentgen manifestations which perplex physicians when discovered accidentally. A consideration of skeletal trauma by physical agents in infants and children generally calls to mind clear cut fractures, epiphyseal displacements and dislocations. Usually, the diagnosis is obvious roentgenographically if not clinically; and a history or signs of injury are present if not the reason for examination. It is not often appreciated that many individuals responsible for the care of infants and children (who cannot give their own history) may permit trauma and be unaware of it, may recognize trauma but forget or be reluctant to admit it, or may deliberately injure the child and deny it. Roentgen examination for reasons other than known injury may demonstrate, after a proper interval to be discussed later, skeletal abnormalities which evoke diagnoses charged with dire prognostic consequences and tremendous emotional unheaval for the patient's family. This paper is concerned with a description of roentgen sequelae to trauma, the nature of which is learned only in retrospect on the basis of correct interpretation of the roentgen shadows.

REPORT OF CASES

CASE I. J. S. was a four and one-half month old, white male infant when admitted to Children's Hospital. He had been born at term as the result of the first pregnancy of a normal mother. Up to the age of four months, the child thrived and appeared to be perfectly normal in all respects, although there were some episodes of colic. Nutrition, particularly with respect to vitamins, was adequate and not excessive. At no time were there any symptoms referable to the central nervous system.

At about four months of age, the child developed signs of upper respiratory infection, with coryza, coughing and sneezing and a slight temperature elevation. His regular pediatrician was out of town and another physician was called to see the infant. The child ate and drank very little during the succeeding four days so that he was admitted to another hospital primarily for subcutaneous fluid administration to combat dehydration. On admission, a nurse called attention to swelling of the right thigh which the parents had not observed before. In retrospect, the parents admitted that for approximately a week to ten days prior to the onset of the respiratory infection, the child seemed somewhat irritable and cried whenever his legs were touched to change the diaper. Roentgen examination of the chest failed to support a suspicion of pneumonia; roentgenograms of the hips and thighs were read as normal. The child was in the hospital four days, recovered from the upper respiratory infection without any ill effect and was apparently well when the pediatrician returned and saw the child on a routine visit, approximately two weeks after the initial signs of upper respiratory infection. At that time, the pediatrician noted a hard swelling in the left thigh and sent the child to the Children's Hospital for study, suspecting possible bone tumor.

On physical examination, the infant was found to be well developed, well nourished, but rather irritable. There were no signs of central nervous system abnormality and, except for the right thigh, the rest of the examination was normal. The right thigh was enlarged, very tender to palpation, and painful when the knee and hip joints were moved. A firm indurated

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FIG. 1. Case 1. J. S., four and one-half month male. Lower extremities April 15, 1949. Note calcifying callus formation outlined by arrows along proximal portion of right femur. Metaphyseal lesions present in left femur and both tibias at knee. Metaphyses are normal in right femur at knee and right tibia at ankle. Symptoms referred only to right thigh.

swelling which was almost bony hard was present deep in the right thigh. Examination of the blood revealed 10.8 gm. hemoglobin, 4.19 million red blood cells, 8,250 white blood cells, with 41 per cent polymorphonuclears, 52 per cent lymphocytes, and 7 per cent monocytes. A urine examination was normal. Kahn reaction was negative. A blood culture contained 33 colonies per cubic centimeter of a gram positive coccus, later identified as hemolytic *Staphylococcus aureus*, coagulase negative. Agglutination tests of the blood for typhoid, paratyphoid A and B infection were negative. Vitamin C level in the serum was 0.48 mg. per 100 cc. Roentgen examination of the skull showed no abnormalities. The heart and lungs were normal roentgenographically. A healing fracture was found near the vertebral end of the tenth left rib and distinct irregularities of bone suggesting metaphyseal fracture were present at the distal end of the left humerus which was included in the projection of the chest. In the lower extremities, extensive polyostotic but asymmetric changes were present throughout the major long bones (Fig. 1). A large area of subperiosteal new bone formation surrounded the proximal end of the shaft of the right femur. The lower portion of the bony mass tapered off into normal bone. In the region of the left knee, there were distinct metaphyseal rarefactions of the femur and tibia associated with slight subperiosteal new bone formation. Along the shaft of the left tibia, there was distinct subperiosteal new bone cloaking, and metaphyseal rarefaction and irregularities were observed at the distal end of the tibia. The left fibula was not affected. Metaphyseal changes were present in the proximal end of the right tibia; the distal end of the right femur was normal. Subperiosteal cloaking was also present along the shaft of the right tibia and fibula but to a lesser degree than on the left. The ossification centers for the femoral heads were not yet visible roentgenographically; lateral and cephalic displacement of the proximal end of the shaft of the right femur was considered to indicate a subluxation of the right hip. Metaphyseal changes similar to those in the lower extremities were found in the left humerus in the region of the elbow and were associated with subperiosteal new bone formation along the distal end of the shaft (Fig. 2*A*). The remaining bones of the upper extremity were normal roentgenographically. The opinion offered on the basis of the roentgenographic examination was that the child had multiple infractions and subperiosteal hematomas as the result of trauma which was either unrecognized or not admitted.

The patient was afebrile at admission and remained afebrile throughout his hospital stay of four days. The suggestion of trauma made on the basis of roentgen interpretation met with considerable resistance on the part of pediatricians and orthopedists who saw the child in consultation. However, in an interview with the parents who had previously specifically denied trauma, at least two episodes were uncovered, both approximately a week before the onset of the respiratory infection and the admission to the other hospital, and three weeks before admission to Children's Hospital. One episode occurred when the baby fell from the mother's arms onto a bed. The distance of fall and the severity could not be ascertained but

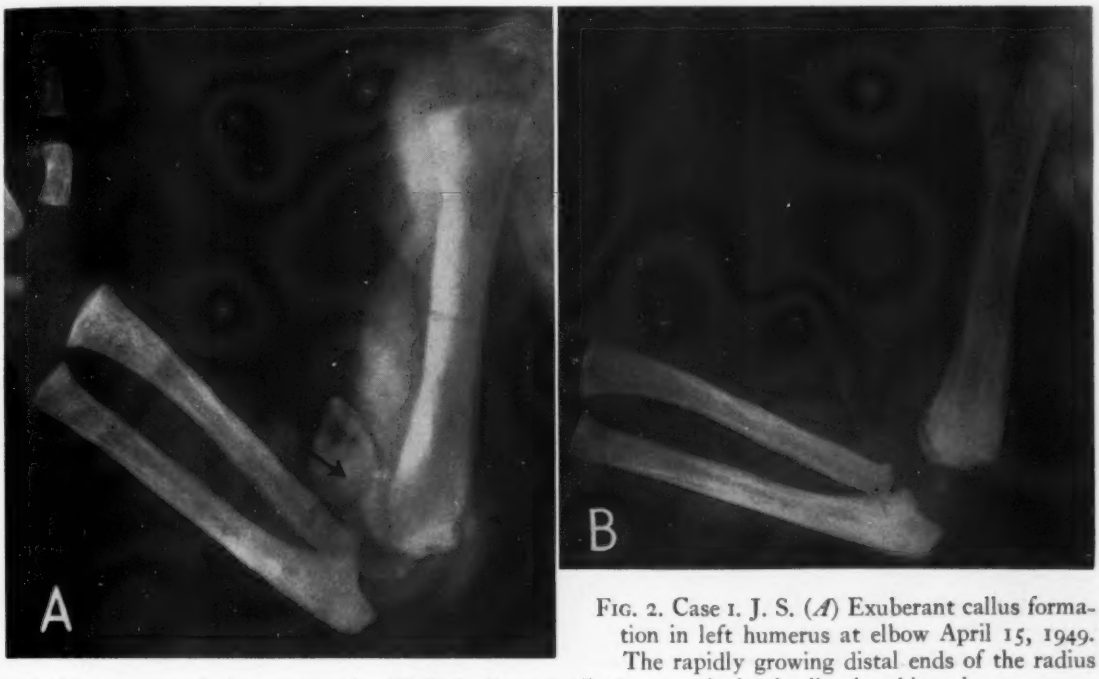

Fig. 2. Case 1. J. S. (*A*) Exuberant callus formation in left humerus at elbow April 15, 1949. The rapidly growing distal ends of the radius and ulna are normal. Asymptomatic. (*B*) Left elbow April 28, 1949. Active healing is taking place.

one gained the impression that the mother was withholding some information. The other episode, and probably the more important one, occurred when a bathinet, in which the baby had been placed, collapsed. The father caught the baby in the air to prevent his hitting the ground, grasping him by the legs, and jerked him violently. Other episodes of trauma were not recalled by either parent.

Shortly after the interview, films became available which were taken during the course of the acute infection at the other hospital, approximately two weeks earlier. Also, a film was obtained which had been taken during the neonatal period as part of a routine examination. The film taken during the neonatal period demonstrated that the femurs were in normal position in relation to their respective acetabular fossas at that time and no fractures were present. The films taken two weeks prior to admission to Children's Hospital (Fig. 3) demonstrated the previously unrecognized fracture near the vertebral end of the tenth left rib, infraction in the distal end of the shaft of the left femur and the apparent subluxation of the right hip with considerable soft tissue swelling. No productive or destructive signs were present. It was felt that a satisfactory explanation of the bizarre roentgen findings had been afforded and the child was discharged

Fig. 3. Case 1. J. S. Film taken April 5, 1949, ten days prior to film in Figure 1. Note fracture of tenth left rib, apparent subluxation of right hip without destructive or productive changes in bone, and metaphyseal lesion in left femur at knee.

Fig. 4. Case I. J. S. Lower extremities April 28, 1949. Metaphyseal lesions have filled in and external callus shows evidence of modelling. Ossification centers for femoral heads have appeared and demonstrate that epiphyseal separation and not dislocation has occurred at right hip.

after a four day period of observation in the hospital.

Follow-up examinations over a period of twenty-six months at the time of writing have demonstrated rapid and complete recovery from the skeletal injuries except in the region of the right hip. The exuberant irregular callus formation at the distal end of the left humerus showed evidence of organization, resorption and modeling thirteen days after our initial examination (Fig. 2*B*). The metaphyseal lesions healed in the lower extremities and resorption of subperiosteal new bone along the shafts proceeded rapidly (Fig. 4). Only in the region of the right hip was there evidence of permanent damage. Here, the appearance of the ossification center for the femoral head within two weeks of our initial examination indicated that an epiphyseal-metaphyseal separation had occurred rather than a subluxation. Firm bony union took place but a coxa vara deformity persisted and the right femur is shorter than the left (Fig. 5). The child runs and walks without obvious disability. The only physical finding of note is limitation of abduction on the right side.

Case II. W. P., white female, aged seven months. The patient was the first born of twins with a birth weight of 3 pounds 4 ounces. Her twin weighed 6 pounds 3 ounces. She was born by spontaneous delivery with a breech presentation. She remained in the hospital two weeks and gained weight rapidly. Dietary history was adequate and vitamin administration was not excessive. The general health was said to be fairly good but abnormalities had been observed in the eruption of teeth. The upper and lower cuspids preceded the incisors in their eruption and appeared in poor position. The father thought that the baby's legs "didn't look right" at birth and it had been thought that the baby's legs were painful when touched. In the two months prior to admission to Children's Hospital, the tenderness of the lower extremities appeared to have increased. On several occasions, the patient was observed to frown and cry out as if in pain; she was described as nervous and "jittery." Development was slow. At the age of seven months the child could not

Fig. 5. Case I. J. S. Lower extremities May 19, 1949. Coxa vara deformity on right. Metaphyseal lesions completely healed.

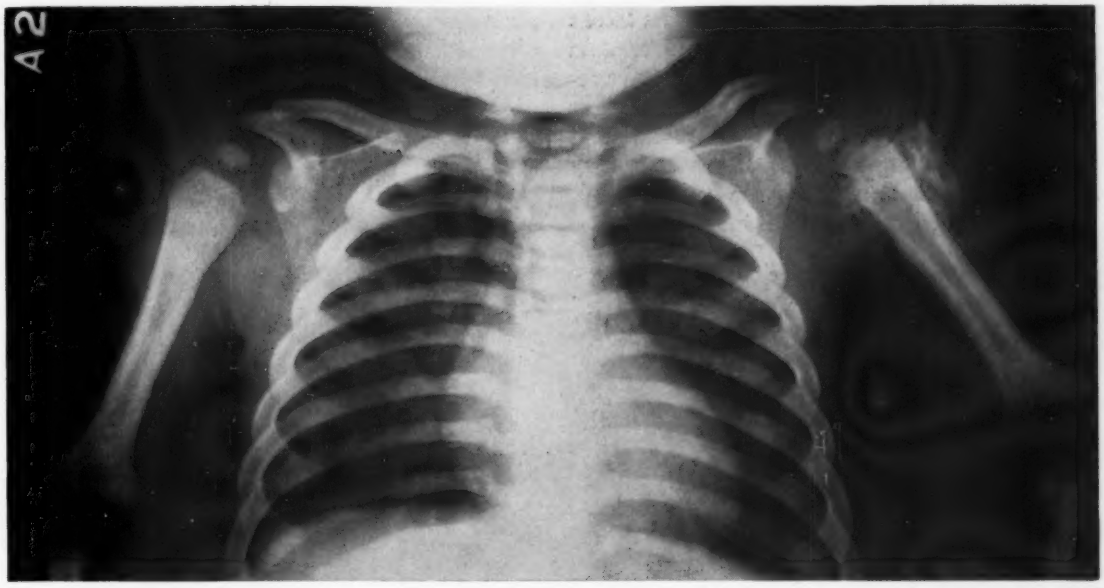

Fig. 6. Case 11. W. P., seven month female. Shoulder girdle May 15, 1950. Injury (burn and contusion) to left shoulder thirty hours earlier. Calcifying callus formation probably at least ten to fourteen days old. Note normal humerus at elbow. Compare with Figure 8.

sit up and, according to the grandmother, handled herself much like a three month old baby.

The patient was brought to Children's Hospital at seven months of age with the story that thirty hours earlier while the mother was ironing at home, an older sibling pushed the baby's bassinet against the ironing board and the hot iron fell into the bassinet striking the infant on the left shoulder, left upper extremity and left chest. A severe burn resulted. Local treatment was given. The following day a physician suggested hospitalization because of the question of fracture of the left upper extremity. On physical examination, the child was small, thin and poorly developed. She weighed 11 pounds 11 ounces; her temperature was 102.8° F. rectally, pulse 160, respirations 84. A second degree burn was present on the left arm and forearm. The patient moved the hand and fingers of the left upper extremity but did not move the elbow. The right arm was used well. A burn was also present on the left lateral chest wall, measuring about 4 cm. in diameter. The liver edge was felt 2 cm. below the right costal margin. The skin was dirty and a small ulcer was present on the genitalia. The lower extremities were held flexed, abducted and externally rotated (frog leg position). The bones of the lower extremities were thickened to palpation, the right more so than the left. Both lower extremities were warm to the touch and were tender.

Laboratory studies revealed a hemoglobin content which varied between 7.4 and 9.1 gm.; 3.2 to 3.8 million red blood cells; 5 to 17 thousand white blood cells, 52 to 73 per cent polymorphonuclears, 18 to 35 per cent lymphocytes, and 9 to 12 per cent monocytes. Except for a trace of albumin, acetone and reducing substance in the urine on admission, all urine examinations were normal. A vitamin C blood level was 0.55 mg. per cent (this was taken the day after the patient received 0.6 cc. of vi-syneral). Tuberculin and histoplasmin skin tests were negative; the Kahn test was negative. No organisms were grown on culture of the blood. Hemolytic *Staphylococcus aureus* was obtained from culture of the nose and throat. *E. coli* organisms were found in the urine and *Proteus morgani* organisms were found in the stool. The nonprotein nitrogen was 48 mg. per 100 cc., calcium 10.5 mg. per 100 cc., phosphorus 4.5 mg. per 100 cc., and phosphatase 11.3 Bodansky units per 100 cc.

Roentgen examination was requested initially of the shoulder girdle and upper extremities. At the proximal end of the left humerus, there was abundant callus formation and irregularity of the underlying bone consistent with a comminuted fracture in the healing stage (Fig. 6). The

fracture was thought to be at least seven to ten days old and therefore unrelated to the trauma of thirty hours earlier. No evidence of more recent skeletal injury was identified. The right humerus, the ribs and clavicles were normal and there were no roentgen signs of rickets or scurvy at the growing ends of the bones or in the epiphyseal ossification centers. It was thought that the observations indicated the child to have been exposed to trauma prior to that incurred at the known accident. The possibility of subdural hematoma was raised. Penicillin was administered intramuscularly and was continued for ten days. The temperature fell to normal within forty-eight hours after admission and remained that way until the tenth day. At this time, an elevation of temperature coincident with the positive stool and urine culture led to the administration of gantrisin and, within thirty-six hours, the temperature was again down to normal. Gantrisin was continued until the day of discharge.

The roentgen diagnosis of traumatic lesions in the skeleton was strongly resisted by pediatricians and orthopedists interested in the child. The day after admission, a complete skeletal survey was obtained. No new information was obtained on examination of the upper extremities. In the lower extremities (Fig. 7*A*) multiple old healing fractures with extensive callus formation were present in most of the major long bones. It was noteworthy that a long bone which had marked bone reaction at one end was perfectly normal at the opposite end. The bones and sites involved included both femurs, the proximal ends of both tibias, and the proximal end of the left humerus. The right humerus, the ribs, clavicles, scapulas, radiuses and ulnas were normal. There were no roentgen signs of skeletal dystrophy or generalized metabolic defect. No dislocations or epiphyseal separations could be identified. The cranial sutures were prominent but there were no signs of fracture. It was thought that the examination was characteristic of repeated trauma to the long bones which demonstrated active attempts at healing. The possibility of associated subdural hematoma was to be excluded.

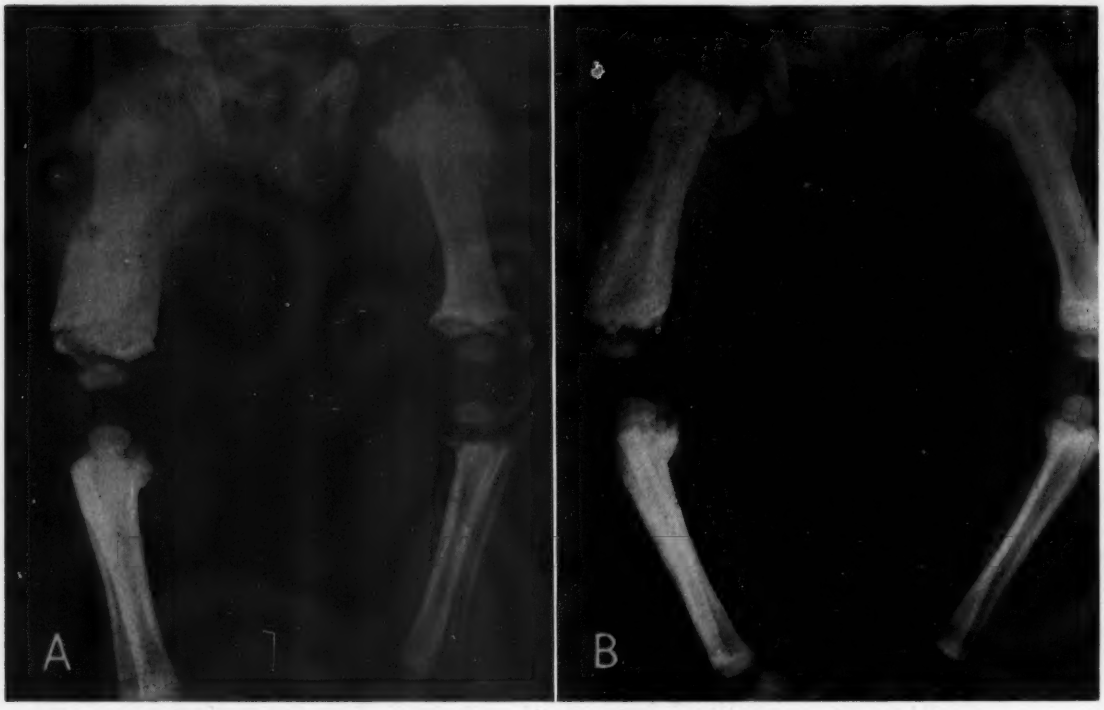

Fig. 7. Case 11. W. P. (*A*) Lower extremities May 16, 1950. Compare lesions with Case 1, Figure 1. (*B*) June 17, 1950. Progressive healing.

Within the next few days, the author had an opportunity to interview the parents and a long series of episodes of trauma was discovered. Chronologically, the history ran in

this fashion: The baby was born October 16, 1949, and admitted to the hospital May 15, 1950. In November, 1949, after an automobile ride, the patient was found to be pale and very limp. The mother's attempts at resuscitation in this and in many subsequent similar episodes was limited to violent shaking of the baby, usually holding her by the arms. This was done for the first time in November, 1949, and the baby survived both the primary difficulty and the treatment. In January, 1950, the child had several episodes in which the arms and legs became caught in the slats of the crib; no trauma was admitted in freeing the baby from these entanglements. In February, 1950, the mother fell downstairs with the baby in her arms. She attempted to shield the baby but did not know whether in her excitement she squeezed the baby hard or not. In the six weeks prior to admission, the baby's bassinet had collapsed three times; at no time was the baby thrown from the bassinet. A nineteen month sibling was said to play vigorously with the baby, pulling at the arms and legs and occasionally sitting on the baby.

The most critical episode, however, was thought to have occurred approximately one month prior to admission when the nineteen month old sibling fed the baby some cotton. The baby choked and the mother picked her up by the legs, inverted her and shook and slapped her violently several times before the baby coughed up the cotton. Demonstrating the fashion in which she held the child inverted by the legs, the mother gave an excellent demonstration of a crack-the-whip technique. Subsequent roentgen examinations demonstrated rapid healing of the lesions, and, of particular interest, metaphyseal rarefaction and irregular subperiosteal new bone formation appeared at the distal end of the left humerus which was roentgenographically normal at the initial examination (Fig. 8). The first appearance of a roentgen abnormality was eight

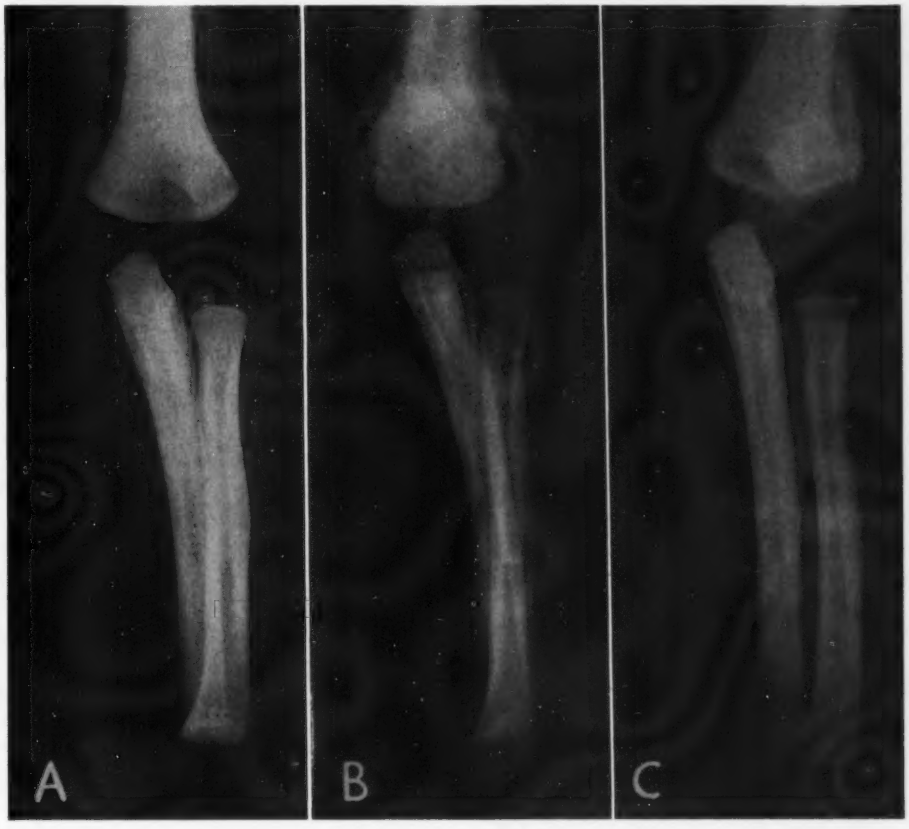

Fig. 8. Case 11. W. P. Serial films of left elbow. Injury thirty hours before first film (*A*) May 15, 1950. Burn healing nicely and arm asymptomatic May 29, 1950 (*B*). Healing progressing June 17, 1950 (*C*)

days after the injury to the left upper extremity and was quite marked fifteen days after the injury. Subdural taps were performed because of the history of nervousness, jitteriness and spells of syncope, but were normal, as were lumbar punctures. The patient left the hospital after a stay of sixteen days, weighing only 1 ounce more than on admission.

The child was subsequently followed in the out-patient department and appeared to get along quite well. Approximately one month after admission to the hospital, the patient weighed 12 pounds 9 ounces and seemed much healthier. A roentgen examination of the long bones at this time demonstrated progressive healing of all the metaphyseal fractures with beginning resorption of the exaggerated callus formation (Fig. 7*B*). The metaphyseal lesions previously marked by demineralization had filled in almost completely and new lesions could nowhere be identified. Distinct remodeling and healing had taken place in the lesion which was observed to develop during hospitalization in the distal end of the left humerus. A roentgen examination of the patient's twin brother failed to show any evidence of skeletal dystrophy, metabolic disturbance or recent or remote fractures. Two months after admission to the hospital, relationships between the patient's mother and the clinic deteriorated. Attempts were made to follow up the child through the Social Service Department but these were unsuccessful as the child died supposedly of bronchopneumonia September 7, 1950. Necropsy was not permitted.

Case III (Courtesy of Dr. Irvin Dunsky). E. G., female aged two months. The patient was seen at two months of age by Dr. Dunsky because of inability to extend the baby's left leg and pain on passive motion. The child had been well previously. Feeding history was not remarkable. The symptoms were said to have been present for a period of three days, progressing from the point of tenderness on palpation to total immobility at the time the patient was seen by the physician. The leg was held flexed at the knee. There was obvious swelling of the left lower extremity, greatest about the knee but extending down the leg to about the midpoint. No restriction of motion at the hip or the foot could be demonstrated but obvious limitation of motion was present at the knee joint. Tenderness on palpation was maximal about the knee and greatest over the area of the tibial tuberosity. The swelling was brawny in nature and pitting edema was not present. No increase in local heat or noticeable change in skin color could be observed. Plantar stimulation of the infant's foot failed to elicit withdrawal of the leg. Pressure on the leg in its longitudinal axis toward the head made the baby cry. *There was no history of trauma.* The child had been taken care of exclusively by the mother who recalled no incident of undue stress to the leg. Nothing in the physical examination or history suggested hypervitaminosis A, scurvy, or metabolic bone disease.

The patient was sent to the Department of Roentgenology of the Children's Hospital for examination of the lower extremities. The initial films showed no evidence of skeletal injury (Fig. 9*A*) but because of the obvious soft tissue swelling it was felt that a repeat examination after an interval of approximately ten days might be valuable in demonstrating reaction to skeletal injury which was initially invisible. The patient was therefore re-examined twelve days later (Fig. 9*B*). All of the bones were normal except the left tibia which by this time was normal clinically. A healing metaphyseal fracture was present at the proximal end of the left tibia. Subperiosteal new bone formation extended down to the distal portion of the shaft. The demineralization and irregularities were considered characteristic of unrecognized skeletal trauma. No other lesions were found in a complete skeletal survey at the time of the second examination. A third follow-up examination was performed twenty-six days after the first examination at which time evidence of healing was observed in the proximal end of the left tibia at the site of the injury.

The author was not able to interview the parents of this patient and the referring physician therefore conducted the interview himself. He elicited the information that shortly before the swelling of the knee was noted, the mother had wrenched the child's knee while changing a diaper. The infant had been in the habit of resisting the diaper change, holding the legs rigidly extended. The mother somewhat exasperated by this apparent lack of cooperation on the part of the infant forcibly flexed the left leg.

DISCUSSION

The 3 patients described above all demonstrated striking roentgen manifesta-

tions of unrecognized trauma. In 2 patients, the skeletal abnormalities were present at the time of the first roentgen examination; in the third, the diagnosis was suspected on clinical grounds, supported by the development of the by then familiar lesions, and proved by parental admission when confronted with the evidence. In none of the patients was there an adequate history of trauma until the roentgen observations indicated the need for careful questioning of those responsible for the infant's welfare.

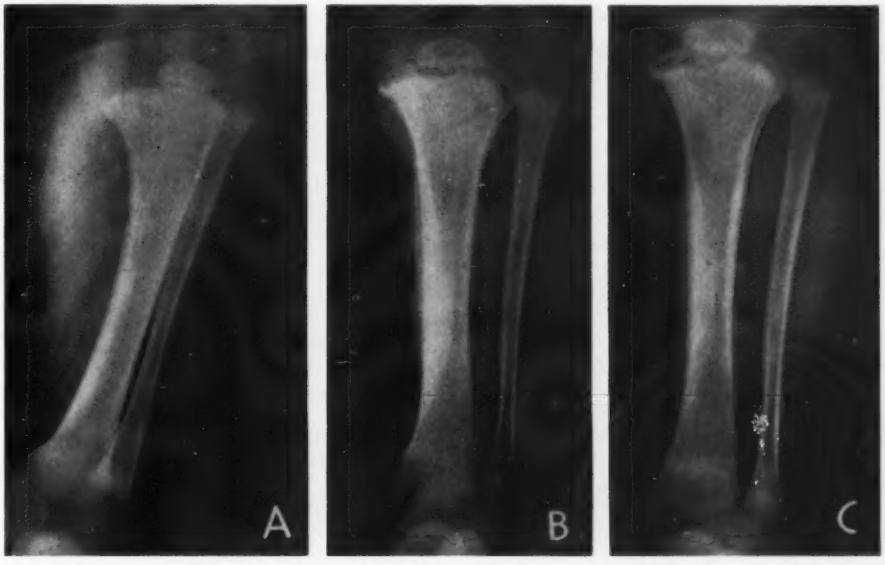

Fig. 9. Case III. E. G., two month female. (*A*) Left leg three days after swelling noted. Tenderness, swelling and limitation of motion present. (*B*) Twelve days later. Asymptomatic. Metaphyseal rarefaction has developed and some subperiosteal new bone is seen along the shaft. (*C*) Two weeks after (*B*). Note early filling in of metaphyseal lesion.

In each case, an admission of injury was obtained, injury not only adequate to explain the clinical manifestations but capable of being related both in time and regions of the body involved to the bizarre skeletal lesions in the roentgenograms.

Other patients have been seen whose history and roentgen examinations are repetitious in comparison with those already described so that report in detail is not warranted. Recently, a five year old girl came to the hospital because of an injury to one arm forty-eight hours earlier while being swung by the arm. The child had favored her arm since the time of injury but played actively up to the time of being seen in the admitting room. Except for the right upper extremity, the only abnormality was a generalized smallness in stature which, when measurements were available, placed the child below the third percentile according to the standards in use in this hospital. Tenderness, swelling and mild ecchymosis were present in the upper arm on the right near the shoulder. Ten months before the acute episode the child fell downstairs while pushing her arm through the rails of a banister and incurred a fracture of the humerus near the elbow.

Roentgen examination of the humeri demonstrated subperiosteal new bone formation at the proximal ends of the shafts of both humeri although only the one was said to have been injured. Deformity secondary to old injury was present at the end of the shaft of the left humerus at the elbow. Re-examination after a two month interval and examination of the remainder of the long bones showed no evidence of basic dystrophy of bone or metabolic disturbance and no other signs of skeletal injury.

Interview with the foster mother disclosed several episodes of trauma. For several weeks prior to the current injury, the child had been actively engaged in playing a game called "statue." In this game, which is somewhat like snap-the-whip, the child is propelled by a playmate or playmates who have hold of her arms, and must remain in whatever position she assumes as a result of being suddenly released. In the course of this game, the child was known to have several very severe falls. The child had also been very active on a trapeze which had been hung up in the back yard of one of her playmates. The restriction of the reparative bone changes to the upper extremities was accounted for by this history; as in other patients, a lesion was present roentgenographically at a site in which no clinical manifestations were present (left shoulder) and this lesion was indistinguishable from those at the site of clinical signs and symptoms. We have seen an infant with healing rib fractures and healing fractures of the humeri similar to those described in this paper discovered in the course of a routine chest examination prior to indicated minor surgery. The lesions had been unsuspected and great concern was felt concerning their nature until it was learned that the child's father had been in the habit of throwing him up in the air and catching him during play.

The exact frequency of the roentgen diagnosis of unrecognized trauma is not known and probably cannot be determined. Not all children who are injured develop the signs of healing bone injury. Since our interest was aroused in this condition, we have examined several children who had been exposed to trauma apparently similar to that which produced the bizarre roentgen manifestations in the children here reported. Examination of the skeleton initially showed no abnormalities and on reexamination, after twelve to twenty-one days, no roentgen sequelae could be identified. It therefore remains possible that an individual factor may be present which predisposes some children more than others to disease of this type. However, the grading of the severity of the trauma is so inadequate that to consider the roentgen changes as anything other than the effects of trauma serves merely to cloud the issue.

No children have died while being followed for these roentgen signs of trauma and examination of the skeleton is not routine in most necropsies so that the histopathologic character of the lesions described roentgenographically is not known. There is no reason to believe that the histopathology would differ appreciably from that of any healing fracture with abundant calcifying callus formation.

Prior to eliciting the critical history of trauma, questions of differential diagnosis were explored by careful evaluation of the roentgenograms in relation to the available history and the clinical condition of the infants. The subsequent history, clinical course and minor laboratory procedures adequately resolved remaining considerations. Any suspicion of a primary bone neoplasm was discarded when lesions identical to those which attracted clinical recognition were found in bones clinically normal. The lesions had none of the roentgen characteristics of primary bone neoplasms and the children were clinically well. The same objections apply to a consideration of neoplasms involving the skeletal system secondarily such as neuroblastoma and leukemia. Polyostotic infection in bone was excluded by the absence of signs or history of infection. Infants are notoriously erratic reactors to infection but some indication should be present with the extensive skeletal involvement demonstrated by Cases I and II. The history of apparent respiratory infection two weeks earlier in the first patient was too recent to account for the degree of productive reaction in the bones. The positive blood culture cannot be explained unless it represents contamination; in the absence of any other sign of blood stream infection, the bacteriologic report probably can be disregarded. Special infections such as tuberculosis and syphilis were excluded by the absence of skin sensi-

tivity to tuberculin and by negative Kahn tests. Moreover, the demonstration of distinct metaphyseal lesions is unusual in the age group of the first two infants and the hyperostoses along the shafts were too extensive to be unassociated with other manifestations of syphilis. In Cases I and III, the asymmetry of the lesions weakened the diagnosis of syphilis as did the monostotic involvement in Case III.

Skeletal dystrophies do not enter the differential diagnosis except as far as osteogenesis imperfecta is concerned. Examination of long bones where lesions were not present failed to show any of the roentgen characteristics of osteogenesis imperfecta. In addition, none of the children demonstrated the characteristic mosaic rarefaction of the skull which should be marked at this age. The possibility of scurvy as a primary disease or as an underlying contributing factor was dismissed on several counts. The dietary history in each case was entirely adequate. Scurvy seldom occurs in infants under six months of age. Case III is far too young for the disease and even in Case I the diagnosis would be questioned on the basis of age incidence. Tenderness of the extremities in Cases I and II is adequately explained by the skeletal injuries; tenderness is not specific for scurvy. The irritability of Case II may well have resulted from discomfort produced by the extensive polyostotic lesions. Bones which were not involved in the destructive or productive processes showed no evidence of metabolic defect such as occurs in scurvy. The epiphyseal ossification centers were normal. Generalized bone atrophy and spurring were not present. Metaphyseal fractures were not observed except where related to direct trauma and in some instances the pathologic change was observed in the more slowly growing end of a long bone rather than in the more rapidly growing end. In fact, the asymmetry of the lesions, the presence of extensive productive and destructive change at one end of a bone while the other end was entirely normal adequately excluded metabolic disease as a primary defect. As a general rule, metabolic diseases affect all the bones and the effects are most marked at the sites where growth is more rapid. The low vitamin C blood levels in Cases I and II are the only features which in any way support the suspicion of subclinical scurvy which contributed to the development of the lesions. However, it has been pointed out[6] that although a fasting vitamin C level of the blood plasma of over 0.6 mg. per 100 cc. aids in the exclusion of scurvy, a lower vitamin C level does not prove its presence. Moreover, the alkaline phosphatase level of 11.3 Bodansky units per cubic centimeter in Case II does not indicate scorbutic depression of osteoblastic activity in the patient for whom the clinical suspicion of scurvy is most justified. Fractures from apparently insignificant trauma have been observed in children without primary skeletal disease but with metabolic disease. We have seen children with the celiac syndrome, who frequently develop marked osteoporosis, get up and walk about at the beginning of their recovery period, and develop fractures from the stresses of weight bearing. Children have also been seen with bone atrophy following poliomyelitis who develop unsuspected fractures following even moderate physiotherapy. In these cases, however, the fractures are readily recognized roentgenographically at the time of the first complaint of swelling or pain.

The literature on skeletal reactions to unrecognized trauma is relatively scanty. Snedecor and his associates in 1935,[7] and more recently in 1949,[8] reported traumatic ossifying periostitis in the newborn infant occurring as a result of obstetrical injury. All patients were born by breech presentation, several undergoing podalic version. Periosteal stripping and epiphyseal injuries were described, singly and in combination. The term "epiphysis" was probably incorrectly used as the illustrations demonstrate metaphyseal injuries similar to those noted in our patients. It was properly pointed out that roentgen examina-

tion at the time of injury failed to demonstrate pathologic change, whereas reexamination after seven to ten days discovered lesions which had been clinically silent or which had clinically resolved. In the children with obstetrical injuries, the roentgen changes occurred primarily in the lower extremities. One instance of upper extremity involvement was included in each report. Ferguson[5] states that posttraumatic hemorrhage and calcification may imitate the form of massive hemorrhage in scurvy and includes an illustration of a ten day old female whose right arm and right leg were injured at birth. Thorndike and Pierce[9] in 1936 noted that 34 per cent of birth fractures reviewed at the Children's Hospital of Boston were not recognized at the time of their occurrence. Caffey[3] has described multiple fractures in the long bones of infants suffering from subdural hematoma. The fractures were in some cases roentgenographically identical with those seen in the children described here. These fractures were either clinically silent or discovered accidentally in the course of other examinations and no adequate history to account for them could be obtained. The possibility of their origin from traumatic episodes unrecognized or not admitted by the infant's custodian was discussed. In one patient, described as an unwanted child, fresh fractures appeared after the child returned home from the hospital. It has been interesting to speculate in this regard, concerning the accident-prone history and ultimate fate of Case II in our series. The frequency of the combination of skeletal and central nervous system disease led to a consideration of subdural hematomas in Cases I and II. The complete absence of central nervous system signs and symptoms appeared sufficient to dismiss the diagnosis in Case I; subdural taps were done in Case II, and no abnormalities were discovered. More recently, Caffey[2] has described unrecognized neonatal contusions and emphasized the unreliability of the history for trauma to infants by mothers and nurses when the usual casual history of trauma is taken. Our interest in the lesions of unrecognized trauma stems from familiarity with Caffey's cases now illustrated in his textbook. Barmeyer, Alderson and Cox[1] have recently described traumatic periostitis in young children characterized by subperiosteal new bone production primarily in the lower extremities. Metaphyseal lesions were not described but the correct identification of the periosteal reaction as a result of trauma was made. The differential diagnosis of subperiosteal new bone formation was discussed. The paucity of literature on the subject of unrecognized trauma in infants and the unfamiliarity with and resistance to the roentgen manifestations and their diagnoses respectively probably rests in part on the fact that a time lag exists between the time of injury and the roentgen appearance of the skeletal response. All the authors quoted are in complete agreement that the condition occurs much more frequently than is generally recognized.

The frequency of these roentgen observations is perhaps better exemplified by the fact that 6 examples of misdiagnosed trauma were seen in consultation by Caffey[4] during the last year. One of the patients, an overactive child, in whom the distal ends of the tibias were spread and cupped with long spurs, habitually climbed onto the top of a large refrigerator and jumped several feet to the floor several times a day. He had been sent to an orthopedist who had made the diagnosis of a muscular dystrophy.

It has been pointed out that the periosteum in the infant is more loosely attached than in the older child or in the adult.[2] As a result, periosteal stripping by apparently trivial trauma may lead to subperiosteal hemorrhage and periosteal elevation. When the periosteum has produced enough calcified bone on its internal surface, it becomes roentgenologically visible as a line of increased density paralleling the shaft. If rupture of the periosteum has taken place, marked irregularity of the subperiosteal new bone formation may

occur. Metaphyseal lesions are somewhat more difficult to explain. In some cases, the presence of a small lesion in the metaphysis is missed roentgenographically through inadequate examination as in Case 1 (Fig. 3) where, because of attention focused on the chest, a metaphyseal lesion in the distal end of the right femur was not observed initially. We are fully aware of the fact that, in many cases, fracture lines are invisible at the time of injury but become visible as demineralization adjacent to the fracture line takes place within the following two weeks. The relationship of the plane of the fracture to the direction of the roentgen-ray beam may affect the visibility of fractures. Comminution of the epiphyseal plate on its immediately subjacent bone may obscure a fracture until the reaction to injury becomes evident. It is not improbable that some of the children described by Barmeyer and his associates[1] actually suffered from fine spiral fractures of the tibia in which the fracture line remained invisible due to technical factors, and the pathologic change was manifest only by the reparative alterations.

How many times have we seen children lifted on or off street cars, vehicles, up and down steps by a well meaning but none the less potentially traumatic pull of an arm? How many children are swung by their parents in play suspended by their arms or their legs? How many children are saved from falls or other injuries which may have serious consequences by a quick grab by a custodian or parent? There is probably hardly a child who at some time during his infancy has not been exposed to trauma of this sort. Only a very small percentage of these infants demonstrate clinical signs of trauma—pain and limitation of motion of an upper extremity after a sudden pull, limp or disinclination to use a lower extremity after some apparently minor maneuver. Responsible custodians of children are deeply and immediately concerned by these manifestations when they occur. The children are brought to the roentgen department for examination but demonstrate no roentgen abnormalities because reparative changes will require time to occur. The invisibility of the lesions early is demonstrated in Figure 8 in which serial films are shown of the elbow of Case 11. The left elbow thirty hours after the known injury showed no evidence of fracture although it will be remembered signs of healing fracture were present at the proximal end of the same humerus. Fourteen days later the characteristic irregular subperiosteal new bone formation was observed in this site, which, except for the burn, had been clinically silent; and four weeks after injury, healing was well advanced. This is the sequence of events in the easily injured bones of infants, which accounts for the relative unfamiliarity with roentgen manifestations of unrecognized trauma.

As pointed out by most of the authors previously mentioned, and particularly recently by Barmeyer,[1] within a matter of a few hours to a few days, clinical recovery generally takes place and indication for reexamination by the roentgen ray no longer exists. The initial incident is forgotten. Should such an infant however be reexamined for another cause after the proper interval, the identification of the extensive skeletal lesions immediately calls for a differential diagnosis including the serious conditions already discussed—neoplasm, osteomyelitis, tuberculosis, syphilis, etc. The emotional impact of these possible diagnoses on the parents of a usually otherwise healthy child is tremendous, and the problem of excluding these diagnoses may be time consuming and expensive. The suspicion of a traumatic basis for the lesions can be no less devastating in its effects on the family of an infant if the history is not properly elicited. The technique of eliciting a history from reluctant or recalcitrant parents will vary with each case. It has been helpful to point out that a diagnosis of a traumatic lesion carries a much better prognosis than other conditions in the differential diagnosis. We have also used the technique of emphasizing that the in-

jury incurred is of no consequence compared to the possible sequelae to the injury from which the child may have been saved. This is particularly valuable when there is reason to believe that an impending fall and possible skull and brain injury was the signal for the alert parent or custodian to seize the child by the most readily available extremity. It is of the greatest importance not to overwhelm those responsible for the care of the infant with feelings of guilt. The relief of emotional tension which follows the admission of previously withheld suspicions concerning the nature of the child's condition has been gratifying to see. On the other hand, in one case in which easily recognizable fractures as well as reparative changes of unrecognized fractures were present, it was deemed wiser to refrain from an interview in order not to precipitate a crisis in a difficult family situation.

SUMMARY

Roentgen examination of infants for causes other than known physical trauma occasionally reveals unsuspected abnormalities of the skeleton. These are chiefly irregular fragmentation of one or more metaphyses in the tubular bones associated with new bone formation external to the shaft. The destructive and productive lesions may be monostotic or polyostotic, symmetrical or asymmetrical. Diagnoses evoked by their often striking appearance usually carry serious prognostic implications and are charged with severe emotional reaction for the patient's family. Extreme care must be exercised not to overwhelm responsible custodians of the infants with feelings of guilt as the history is elicited. The usual excellent prognosis of traumatic lesions compared with that of the diseases considered in the differential diagnosis makes recognition of the roentgen signs important. The roentgen manifestations of unrecognized skeletal trauma in infants are described and serial studies which demonstrate the evolution of the roentgen lesions are presented.

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DISCUSSION

Dr. Edward B. D. Neuhauser, Boston, Mass. Dr. Silverman has presented his thesis so lucidly that there seem to be no problems left for me to discuss. We have had the same experience that Dr. Silverman has had in that it is difficult to obtain the history from the family. We often have obtained no history of trauma. Our great difficulty is convincing the pediatrician and the orthopedic surgeon that trauma is the explanation for some of these bizarre and rather unusual bone changes. Every case that comes in, as is suggested, has been an example of needless expense to the hospital or to the patient in our hospital, with endless blood cultures, many studies, search of old films to see if it didn't really resemble scurvy and the roentgen department has forgotten what scurvy looks like, not having seen a case for some months, so it always creates quite a problem.

There are many periods when the infant's skeleton can be insulted. Of course, the first is the obstetrical trauma with which most of us are familiar. Many of the lesions, if not most of them, have the appearance of those presented by Dr. Silverman, It is very difficult when one does not have the history to recognize the lesions early. Once in a while one can, particu-

larly if it is a history of breech extraction, by carefully examining the knees and the shaft to see if one shaft doesn't point off northeast a little bit rather than being correctly aligned to the acetabulum or to the joint.

The next type of trauma is that which is incidental to ordinary family life, and I think it was Dr. Archer who said that the incidence of injury goes up in inverse proportion to the intelligence of the parents, and particularly to their addiction to inebriating liquors, because most of the ones we have seen have been where the father has come home intoxicated and wanted to play with the child and tossed it back and forth to a family friend.

A third group is that type of injury that the child may inflict upon himself because of his condition. We frequently see fractured ribs in the presence of respiratory difficulty, pneumonitis, or tracheal obstruction. They evidently represent fatigue fractures.

The recognition of these traumatic lesions is not easy. Certainly in the early stages it may be extremely difficult or impossible, and I think perhaps that is rather fortunate, because if many of these were picked up early, they would get into the hands of the general surgeon and the orthopedist who is used to handling adults chiefly, and, with a great deal of enthusiasm, he will attempt to do what nature can do better; that is, he will attempt reductions, and immobilization in plaster, and in many instances will dangerously traumatize the growing cartilage at the end of the bone with resultant shortening.

I would certainly like to congratulate Dr. Silverman not only on his unusually good presentation but on the quality of the paper.

THE USE OF UROKON IN CEREBRAL ANGIOGRAPHY*

A PRELIMINARY REPORT

By H. HARVEY GASS, M.D., *and* SAMUEL D. JACOBSON, M.D.

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WITH the increased use of cerebral angiography in neurological diagnosis the occasional occurrence of untoward reactions is distressing. Despite refinements of technique, greater skill, and wiser selection of patients, these reactions still occur and therefore reduce the applicability of this technique. In a series of excellent papers by Broman *et al.*[1,2,3] it has been shown that the extent to which the blood-brain barrier is disturbed in performing a cerebral arteriogram (and presumably therefore the likelihood of producing a clinical accident) depends upon the toxicity of the specific contrast medium used, concentration of that medium, and the length of time that this medium is in contact with the cerebral blood vessels. The purpose of this paper is to report our experience in humans with a new untried contrast medium, urokon, in an effort to find a substance which might further reduce the toxicity factor.

Urokon sodium has found its greatest use thus far in urography. It is an aqueous solution of a high iodine containing compound used in a 30 per cent concentration. Its safety and utility as a contrast medium for urological investigation has been established by Nesbit and Lapides,[4] and Richardson and Rose.[5] The reported low incidence of secondary reactions led us to test this material in cerebral angiography. The material† used in this study differs from the commercially available Urokon sodium only in that the pH of the tested material has been made iso-electric with blood in contrast to the pH of 5.2 of the standard commercial preparation. Urokon sodium is excreted through the kidney.

We have performed 62 arteriograms with this material in 52 different patients, all done percutaneously. No injection contained more than 12 cc. of medium, and with the exception of the first few where smaller quantities were tried, the quantity of material used was never less than 8 cc. As a rule, each injection was 10 cc. Usually at least two injections were made, sometimes one following the other immediately, but more frequently with an interval of five minutes or more between injections. On one occasion six injections were made (Table 1). All but 12 of the arteriograms were done under local anesthesia with the patients fully conscious. Nine of these 12 were done with the patient under general anesthesia; the other 3 were done in comatose patients. In 2 instances the urokon was diluted to 20 per cent and in 1 patient to 10 per cent, but the resulting arteriograms were too faint to qualify as adequate cerebral arteriograms. In nearly all cases the artery was successfully punctured within the first two or three tries. In a few cases it was necessary to probe longer.

In all patients, injections were made into the internal or common carotid artery except one, in whom two injections were

TABLE I

NUMBER OF INJECTIONS AND QUANTITY

Number of Injections	Quantity	Number of Arteriograms Urokon 30%
1	10–12 cc.	14
2	20–25 cc.	34
3	30–36 cc.	6
4	40–48 cc.	5
5	50–60 cc.	2
6	60 cc.	1
TOTAL		62

† Material used in this study is not yet commercially available. It was provided for this study by Mallinckrodt Chemical Works.

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made into the vertebral artery and three into the carotid artery.

In several instances injections of urokon were alternated with injections of 35 per cent diodrast in an effort to compare the amount of pain produced by the injection of each of these substances. No accurate evaluation of this was possible since the amount of pain reported depended upon the patient's own apprehension, which substance was injected first, how long a period elapsed between injections, and other uncontrollable factors. The general impression from these comparisons, however, and from our experience with urokon as contrasted to a large earlier experience with 35 per cent diodrast was that it was somewhat less painful than diodrast, but still produced a burning, hot feeling on the side of the face and behind the eye. On many occasions the patient described this feeling, but denied that it was distinctly painful. Four patients who had both urokon and diodrast without knowing which was which reported that the injection with diodrast hurt worse; 1 patient reported that the injection with urokon hurt more; while the reports from 3 patients were conflicting and uncertain.

In 3 patients the medium was inadvertently injected into the soft tissues of the neck. In 1 a check-up film taken twenty-four hours later showed that all of it had been absorbed. In the second patient a film taken six hours after injection showed that all the medium had been absorbed. In the third patient a two hour film showed that all the medium had been absorbed. None of these patients complained of more than the usual tenderness in the neck which follows percutaneous cerebral angiography.

SIDE REACTIONS

In 4 patients within two minutes of the injection there was some nausea, and in 3 other patients actual gagging occurred (Table II). This was distinctly less with a second injection of the same material. One patient vomited following an injection of diodrast, but not following each of two subsequent urokon injections. Five patients at the moment of injection began to salivate and expectorated saliva. In only 1 patient did these reactions interfere with the quality of the resulting arteriogram. Frequently the patients experienced a bitter taste in the mouth at the time of injection. Three patients reported feeling something pouring or bubbling into the mouth at the time of injection. There were no late reactions in any of these patients, with the possible exception of 1, an epileptic who had had no seizure in five months but who, on the day following arteriography, had one convulsion. In this patient, however, both diodrast and urokon were used.

Table II

SIDE EFFECTS

Number of Patients	Nausea	Gagging	Salivation	Neurological
Total 52	4	3	5	1

There was only one neurological reaction experienced. This was in a fifty year old, extremely obese woman who had had intermittent proptosis of one eye. The carotid puncture was made with ease and, following the first injection, nothing unusual was noted. However, within about two minutes following the second injection, which was done five minutes after the first injection, the patient noted numbness in the right arm and leg, followed by marked weakness of these extremities. At the same time she demonstrated motor aphasia. There was no disturbance of consciousness. Within five minutes these symptoms began to improve, and within thirty minutes full motor and sensory recovery had taken place, but the aphasia had not completely recovered. Some aphasic deficit was still present the following day, but two weeks later it was reported that she had fully recovered all functions. The arteriogram was normal.

Arteriograms were done in 5 patients over the age of sixty without reactions.

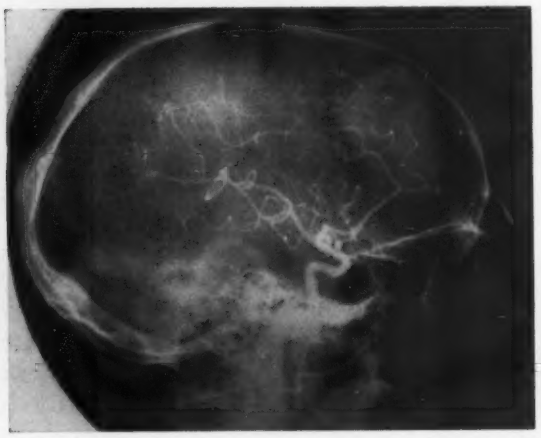

FIG. 1. Normal arteriogram. Lateral view.

TABLE III

Ages Years	Number of Arterio-grams	Arterio-grams Done in Patients Comatose or under Anesthesia	Neuro-logical Reactions
0–10	1	1	
11–20	7	2	
21–30	5	3	
31–40	9	2	
41–50	25	3	
51–60	10	1	1
61–70	5	0	
TOTAL	62	12	1

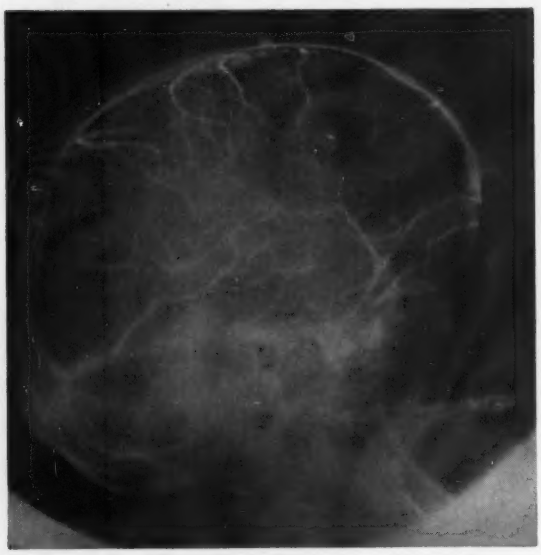

FIG. 2. Normal venogram. Lateral view.

The oldest patient was sixty-eight, and the youngest ten. Most of the patients were in the fifth decade of life (Table III).

The quality of the films with 30 per cent urokon sodium was equally as good as with 35 per cent diodrast, and in some instances superior (Fig. 1–5). Almost all of the exposure times in taking these films

FIG. 3. Normal venogram. Anteroposterior view.

FIG. 4. Shift of first portion of anterior cerebral artery. Anteroposterior view.

was one-fourth of a second or less. Most of the urokon arteriograms did not have quite the sharpness in contrast of those we have made with thorotrast, but with the latter medium we have always used a time exposure of one second, which may account for the superior quality of films we have obtained with this agent. Arteriography was done in 1 patient who, several months following a prefrontal lobotomy (where 1 cc. of lipiodol had been instilled in the leukotomy incision on each side), developed

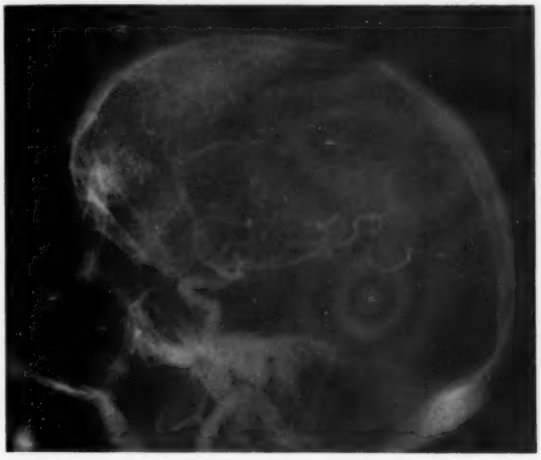

Fig. 5. Increased vasculature in a frontal lobe tumor (glioblastoma multiforme). Lateral view.

a right frontal brain abscess. Thorotrast had been instilled into the abscess cavity. Arteriography was done as a base line dedermination for future comparison as additional help in following the course of the abscess. This provided an unusual film (Fig. 6) showing lipiodol, thorotrast, and urokon in one film (also air from an initial attempted ventriculogram). There was no significant difference in the quality of contrast with these three substances.

SUMMARY

Our experience in using a specially prepared iso-electric solution of urokon sodium (not yet commercially available) in sixty-two arteriograms performed percutaneously in fifty-two patients is reported.

1. Films of uniformly good quality were obtained.

2. In only twelve patients non-neurological minor side reactions occurred consisting of nausea, gagging, and salivation. The injection was frequently painful. These side reactions and the pain appeared to be no greater, and possibly somewhat less, than those occurring with 35 per cent diodrast.

3. In one patient a neurological reaction developed which consisted of transient aphasia and hemiplegia from which the patient quickly fully recovered.

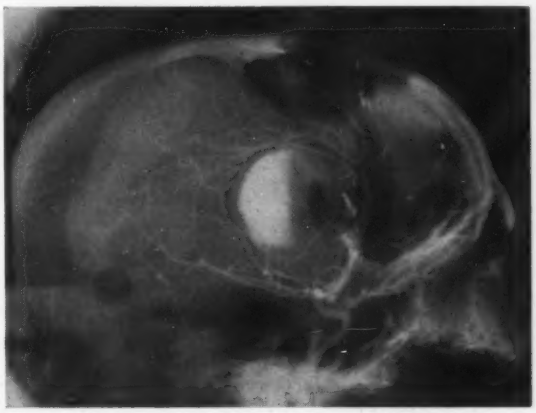

Fig. 6. Brain abscess and arteriogram. Lateral view. See text.

CONCLUSION

From this preliminary report, it appears that urokon sodium 30 per cent (iso-electric solution) can be used as a contrast medium in cerebral arteriography with no greater risk or discomfort than with 35 per cent diodrast, and the resulting arteriograms are of a comparable quality.

Further clinical trial of this material is being carried out.

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ADDENDUM

Since this manuscript was submitted another report concerning urokon in cerebral arteriography has been published.[6] Experience reported therein with 40 arteriograms corresponds well with that in this report.

Mallinckrodt Chemical Company has discontinued issuing urokon sodium 30 per cent with a pH of 5.2 and is now issuing only urokon

sodium 30 per cent in an iso-electric state such as was used in this study.

Our experience with urokon sodium 30 per cent in cerebral arteriography now totals about 200 consecutive arteriograms without death or permanent neurological deficit. Most of these, however, have been done using only 5 cc. of contrast medium per injection.

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INTRAVENOUS UROGRAPHY BY RAPID INJECTION

FURTHER RESULTS WITH AN IMPROVED METHOD*

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IN JULY, 1949, the results of intravenous urography in 200 cases were reported from this hospital.[7] The method used, namely, the rapid intravenous injection of neo-iopax, *i.e.*, within a minute or less, virtually eliminated the arm pain sometimes encountered in the use of this contrast medium. No serious reactions were experienced with the method even in patients with diagnoses which might, according to the manufacturer's instructions, be considered contraindications to the use of neo-iopax. No true sensitivity reactions appeared in the series.

During the year 1950, an additional series of 600 cases, followed with respect to diagnosis, age of the patient, and reaction to the drug used, have been accumulated. These cases confirm the findings in the earlier report that rapid intravenous injection (in less than thirty seconds in this series) of neo-iopax is the method of choice, that all except an occasional, brief, initial, mild arm pain can be eliminated with this procedure, and that there exist no true contraindications to neo-iopax.

The rapid method of injection is of value in those instances where the volume of work puts available time and equipment at a premium.

Since the original demonstrations that highly satisfactory urograms could be made with neo-iopax[9,25,28,29,30] this contrast medium has come to be widely used for intravenous urography and retrograde pyelography. Numerous reports refer to the nontoxic nature of neo-iopax and to the lack of serious side actions with its use.[2,3,6,8,15,17]

In each of the 600 patients here reported, 20 cc. of 50 per cent neo-iopax* (sodium iodomethamate U.S.P.) was injected rapidly into an arm or leg vein (usually within thirty seconds) and the patient's reaction observed over the next thirty minutes. The patients ranged in age from eight months to eighty-seven years. The diagnoses or presenting signs and symptoms are shown in Table II. Technical procedures in patients seriously ill did not vary from those in average cases. Visualization equalled that obtained with iodopyracet (diodrast) which previously has been used at this institution.

Our results in these 600 cases proved that we were correct in deviating from the manufacturer's directions for the slow injection of neo-iopax.[7] Over 80 per cent of our patients, most of whom were elderly, had no reaction whatever. Of the reactions observed, approximately half were arm pain which usually was transitory. Recently neo-iopax has been used for angiocardiography, the visualization of the heart, the pulmonary circulation, and the great blood vessels. For this procedure the manufacturer's instructions direct the injection of 45 cc. of a 75 per cent solution of neo-iopax within one and one-half seconds or less. Robb and Steinberg[19,20,21,22] described the technique for the injection of contrast medium within two seconds for angiocardiographic purposes and this has become standard practice.[13,23,26] It has been employed for angiocardiography in more than 6,000 instances by many investigators,[5] and several reports have appeared in the literature on the use of neo-iopax

* Neo-iopax is manufactured by the Schering Corporation, Bloomfield, New Jersey.

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by this technique.[4,5,10,24] Dotter and Steinberg[4] rapidly injected 15 cc. of 75 per cent neo-iopax in infants and 45 cc. in adults for angiocardiography in 448 instances among 305 patients. The reactions noted were feeling of mild heat spreading throughout the body, headache, weakness, flush, pallor, and thirst, none of them serious nor lasting. Transient arm pain, "usually associated with stenotic lesions of the subclavian and innominate veins or the superior vena cava and . . . thought to represent local venous spasm"[4] occurred in 6 instances. There were no serious reactions.

Other investigators have used the rapid injection technique with neo-iopax for intravenous urography, Pritchard[16] in children, Armbruster and Hefke[1] and Richardson and Rose[18] in adults. Vesey *et al.*[27] have injected 50 cc. of 75 per cent neo-iopax intravenously in less than two seconds for nephrography.

Table 1 shows the numbers and percentages of patients in our series of 600 reacting to injection in thirty seconds of neo-iopax. No reaction whatsoever occurred in 482 patients, 80.4 per cent, despite the advanced age of many and the fact that they were seriously ill. Arm pain lasting less than five minutes occurred in 50 patients, 8.3 per cent.

In most instances, pain was attributed to infiltration of the drug into the subcutaneous tissues rather than to venospasm due to direct contact of neo-iopax with the vein. This difficulty can largely be overcome by the use of a 20 gauge, short bevel needle. After the lumen has been entered with such a needle, there is less likelihood of passing again through the vein with resulting extravasation. This precaution is one of the factors to which Pearman[14] attributed the absence of arm pain and some other unpleasant symptoms in a series of 200 patients receiving neo-iopax. Armbruster and Hefke[1] thought that faulty technique accounted for arm pain in a minimal number of patients and that the pain most frequently encountered was due to venospasm. They found a definite correlation between the rate of injection of neo-iopax and the percentage of patients with arm pain. The percentages of patients with no pain following the injection of 30 cc. of 50 per cent neo-iopax in thirty seconds or less, in one minute, in two minutes, and in three or more minutes was 81, 76, 52, and 40 per cent, respectively, in groups of 75 patients each. Of 150 cases in the series of Richardson and Rose,[18] 12 patients (8 per cent) complained of local arm pain when the medium had been spilled outside the vein. Only 4 patients (2.7 per cent) had severe arm and shoulder pain; in 2 of them there had been visible spilling of the medium. Their 10.7 per cent of patients with arm pain following injection in thirty seconds compares well with the 8.3 per cent in our series.

Dizziness, nausea, and flushing usually started immediately following completion of the injection. Twenty-seven patients, or 4.5 per cent, experienced nausea, and 18, or 3 per cent, flushing and a sensation of warmth spreading over the body. Vomiting, which was our most severe reaction, occurred in only 3.8 per cent of the patients and began in almost every instance two to three minutes after completion of the injection. None of the reactions lasted more than five minutes. There were no sensitivity reactions to the drug.

In Table II patients are grouped as far as possible according to diagnosis. As these were routine, unselected patients undergoing urography in our department, the diagnosis sometimes had not been made.

TABLE I

PERCENTAGE OF PATIENTS SHOWING A REACTION TO RAPID INJECTION OF NEO-IOPAX

Reaction	No. Patients	Per Cent
No reaction	482	80.4
Arm pain	50	8.3
Nausea	27	4.5
Nausea and vomiting	23	3.8
Flushing; warmth	18	3.0
Total	600	

TABLE II

DIAGNOSES OF 600 PATIENTS EXAMINED ROENTGENOGRAPHICALLY WITH NEO-IOPAX USING A RAPID INJECTION TECHNIQUE

Diagnosis	No. Males	No. Females	Age Range, Males	Age Range, Females
Abscess, perinephric	1		39	
Abscess, perinephric (?)		1		21
Abscess, periurethral	1			
Adenoma, pituitary; headache		1		20
Adenoma, thyroid		1		38
Albuminuria	1	1	25	43
Anemia, pernicious; hypertension; hiatus hernia		1		
Anomalies, congenital		2		11–13
Anuria		1		55
Aphasia, metastatic sensory; tuberculosis (?)	1		52	
Appendicitis, acute, with red blood cells in urine	1		33	
Arteriolonecrosis	1		42	
Bladder control, loss of	2			
Calcification, perinephric	1		11	
Calculi, renal; renal neoplasm	1		42	
Calculus, renal (?); cholecystitis; peptic ulcer	1		49	
Calculus, ureteral	3	3	23–66	25
Calculus, urethral	2		50	
Carcinoma, abdominal; hepatosplenomegaly		1		70
Carcinoma of bladder	3	2	50	60–71
Carcinoma, bronchogenic (?); nodularity in right prostatic lobe	1		63	
Carcinoma of cervical lymph nodes, metastatic	1		55	
Carcinoma of cervix		10		29–73
Carcinoma, gastroinestinal or genitourinary	2	2	63–65	49–54
Carcinoma of kidney	13	3	43–78	41–65
Carcinoma of liver, metastatic	1		70	
Carcinoma of lung	2	1	49–52	50
Carcinoma of ovary		1		47
Carcinoma of ovary (?)		3		54–65
Carcinoma of penis	2		67–71	
Carcinoma of prostate	16		54–87	
Carcinoma of prostate (?)	1		61	
Carcinoma of stomach	1	2	63	59
Carcinoma of thyroid, metastatic	1		55	
Carcinoma, undetermined primary site	4	4	52–85	53–72
Cerebral vascular accident; diabetes	1		62	
Cerebral vascular accident; local reaction	1		41	
Cholecystitis, acute		1		75
Cirrhosis of liver	2		36–54	
Colic, renal including renal calculi	26	16	25–63	17–66
Colic, renal; non-functioning left kidney	1		24	
Cystitis	3	4	35–72	8–83
Cystocele		1		67
Cystocele, recurrent; hydronephrosis		1		47
Damage, urinary tract (?)	2	1	65–79	35
Disease, arteriosclerotic heart	2	1	74–89	68
Disease, hypertensive arteriosclerotic heart		1		74
Disease, hypertensive cardiovascular	2	2	50	40–52
Disease, kidney (?)		1		65
Disease, kidney; diabetes (?)	1		64	
Disease, kidney; rectal stricture	1		80	

TABLE II—*Continued*

Diagnosis	No. Males	No. Females	Age Range, Males	Age Range, Females
Disease, rheumatic heart	1	2	17	33–42
Diverticula of bladder	1	1	86	60
Dysuria; fever of unknown origin		1		59
Dysuria; hemiplegia	1		64	
Dysuria; incontinence	1		79	
Epididymitis; bladder atony	1		73	
Extrophia of bladder		1		3 mos.
Fistula, rectovaginal		1		
Frequency, urinary	4	5	57–65	33–42
Glomerulonephritis, acute	2	1	7–45	
Glomerulonephritis, chronic diffuse		2		36–59
Heart failure, congestive; malignancy (?)	1		78	
Hematuria	11	8	17–64	60–85
Hemiplegia or cerebral vascular accident	1		60	
Hepatitis, infectious	1		41	
Hernia, diaphragmatic (calculi); prostatic carcinoma	1		78	
Hernia, inguinal; postoperative fever	1			
Hydrocele	2			
Hydronephrosis, bilateral	1	1	65	32
Hydronephrosis, unilateral	7	3	29–72	35–67
Hydronephrosis, unilateral (?)		1		56
Hypernephroma	1	1	47	46
Hyperparathyroidism		1		38
Hypertension, essential	1	3		41–64
Hypertension; albuminuria; pregnancy		1		
Hypertension, malignant	2		39–46	
Hypertension; tuberculosis (?)		1		44
Hypertrophy, prostatic	39		37–84	
Hypertrophy, prostatic; carcinoma of large intestine	1		70	
Hypertrophy; prostatic; frequency; dysentery; vomiting	1		72	
Hypertrophy, prostatic; cystitis; nausea; vomiting	1		68	
Incontinence	2	1	65	
Infection, urinary tract	2	2	70–80	8 mo.–25
Kidney, delayed filling of	1		2	
Kidneys, polycystic		1		33
Kidney, polyplastic (?)	1		67	
Lymphopathia venereum		1		58
Miscellaneous	24	14	19–70	35–72
Myelitis, transverse	1		43	
Neoplasm, retroperitoneal	1		20	
Nephrectomy, postoperative	2	2	7–59	58–60
Nephritis, chronic		1		28
Nephritis (?); genitourinary pathology (?)	1		40	
Nephrofibrosis (?)		1		37
Nephroma (?)	1		64	
Nephroma, hypogastric	1		50	
Nephroptosis	1	2		26
Nephrosis	1	1	1½	50
Nephrosis (?)	1		51	
Nephrosis; essential hypertension		1		33
Nocturia	2		60–74	
Neuroblastoma (?)		1		
Obstruction, urinary tract	4		45–70	

TABLE II—*Continued*

Diagnosis	No. Males	No. Females	Age Range, Males	Age Range, Females
Osteoarthritis, spine	1			
Osteolytic process in L-4		1		70
Osteoporosis; (?) renal function	1		83	
Pain, abdominal	19	11	20–72	25–60
Pain, back	12	9	23–64	18–56
Pain, costovertebral angle	1		61	
Pain, costovertebral angle; urgency		1		52
Pain, epigastric	1		17	
Pain, flank	8	5	45–70	22–60
Pain, gastric	1		47	
Pain, genitourinary	6	2	10½–74	29–74
Pancreatitis	1		57	
Papillocarcinoma, uterine		1		40
Papillomata, bilateral	1			
Paralysis, agitans	1		67	
Paraplegia	6	1	7–35	23
Pathology, genitourinary	12	9	21–73	15–40
Peritonitis, tuberculous		1		54
Pheochromocytosis	1		54	
Pneumonia; glomerulonephritis		1		55
Pneumonia right lower lobe, unresolved; acid fast bacillus (?)	1		63	
Polycythemia vera	1		57	
Prostatitis	1		50	
Prostatitis; hydronephrosis	2		14–28	
Pyelitis		1		18
Pyelitis (?)		1		19
Pyelonephritis, bilateral	1		26	
Pyelonephritis, chronic	2		5–58	
Pyelonephritis, chronic (?)	1			
Pyelonephritis; cystitis	1		4	
Pyelonephritis, unilateral	8	14	17–69	30–88
Pyelonephritis, unilateral (?)		2		50
Pyelothrombosis	1		68	
Pyuria	3		55–80	
Retention, urinary	7	2	38–70	35–55
Sclerosis, tuberous	1		10	
Septicemia (?)	1		51	
Shunt, splenic-renal		1		30
Splenomegaly; carcinomatosis		1		57
Stricture, urinary tract	5		35–60	
Triplegia, traumatic; kidney disease		1		43
Tuberculosis	3		19–63	
Tuberculosis (?)	1	1	61	19
Tuberculosis; prostatic carcinoma	1			
Tuberculosis, pulmonary	6		47–77	
Tuberculosis, pulmonary and cervical		1		
Tuberculosis, pulmonary; abdominal tumor		1		23
Tuberculosis, pulmonary, and renal	2		45	
Tuberculosis, pulmonary; tuberculosis, renal (?)	1	1		33
Tuberculosis, pulmonary; hypertension	1		40	
Tuberculosis, pulmonary; pericarditis	1			
Tuberculosis, pulmonary; prostatic hypertrophy; urethral obstruction	1		71	

TABLE II—*Continued*

Diagnosis	No. Males	No. Females	Age Range, Males	Age Range, Females
Tuberculosis, pulmonary; right nephrectomy	1		24	
Tuberculosis, pulmonary (?); kidney (?)	1		52	
Tuberculosis, renal	1		50	
Tuberculosis, renal (?)	2	1	40–67	45
Tuberculosis, renal; meningitis	1		59	
Tuberculosis, renal; gastric carcinoma	1		49	
Tuberculosis, urinary tract		1		45
Tuberculosis, urinary tract (?)		1		66
Tumor, abdominal	7	5	27–61	13–68
Tumor, maxillomandibular	1		55	
Tumor, renal	7	1	50–58	41
Tumor, renal (?); aortic aneurysm	1			
Tumor, retroperitoneal; hypernephroma (?)		1		45
Tumor, urinary tract	1		79	
Ulcer, peptic (?)	1		36	
Uremia (?)		1		64
Uremia; chronic pyelonephritis	1		40	
Urethritis, gonococcal	1		36	
Uterus, prolapse of		1		55
Vena cava syndrome, superior	1		56	

In some instances, therefore, the presenting signs and symptoms have been recorded. A question mark indicates that a diagnosis had not definitely been established. For the sake of simplicity, tentative diagnoses were included with established diagnoses, in the following number of cases: renal colic including renal calculi 11; renal pathology 8; renal tumor 3; carcinoma of the kidney 8; abdominal tumor 1; miscellaneous diagnoses 5; renal pain 2; and carcinoma of undetermined origin 2.

We did not consider any illness a specific contraindication to urography. If the patient's condition permitted him to be moved to the roentgen department for a survey roentgenogram, then urography might be attempted as well. A glance at the diagnoses in Table II will show that we included patients with diagnoses which according to the statements in New and Nonofficial Remedies[12] and the manufacturer's literature would represent contraindications. The former reads: "The intravenous use of the drug is contraindicated in the presence of severe liver disorders, nephritis and severe uremia; it should be used with caution in cases of tuberculosis and hyperthyroidism. Preliminary liver and kidney function tests are advisable in suspected cases of malfunction. Caution must also be exercised in patients who have any severe systemic disease."

We present 2 case histories to illustrate the types of cases which were injected without reaction and wherein the procedure formerly would have been contraindicated because of the primary diagnosis.

CASE 1 (6126-51). M.M. This patient, female, aged fifty-nine, first entered Bellevue Hospital on January 26, 1951, with a chief complaint of increasing weakness and dyspnea of two weeks' duration, with swelling of the face and blood in the urine.

The patient had been relatively well until seven years prior to admission when she became weak and dyspneic and was told, after an electrocardiogram, that she had had a heart attack. She was confined to bed for six weeks. In the ensuing years she felt well except for substernal oppression brought on by exertion and relieved by nitroglycerine and rest. One year prior to admission, she developed paroxysmal nocturnal dyspnea. She improved with digitalis but discontinued it within two and a half months because she was "tired of pills." Digitalis was reinstituted early in January, 1951, again with

improvement. At the same time there occurred darkening of the urine and the patient was referred to Bellevue Hospital for acute exacerbation of chronic glomerulonephritis although she denied history of kidney disease.

Questioning and examination revealed no edema, headaches, or visual disturbances and no edema or convulsions during pregnancy. Additional history revealed swollen eyelids and face eighteen years previously at which time the patient was told she had hypertension.

Examination. Blood pressure 190/100; pulse 88; respirations 18; temperature 99.2°F. The patient was obese, plethoric, mildly orthopneic, but not cyanotic and in no distress. Ears, nose, and throat were negative. Fundi revealed narrowed arterioles with small hemorrhages. Moist rales at the bases of both lungs with diminished breath sounds. Point of maximal impulse in 5th interspace, 2 cm. outside the mid clavicular line. Presystolic gallop at aorta and pulmonic area. Short blowing systolic murmur at base of heart. Liver, 2 fingerbreadths below costal margin; 2 plus sacral edema; 2 plus pretibial edema. Heart eccentrically enlarged to right and left.

Laboratory Findings. Urine, sp. gr. 1.010; albumin 2 plus; several granular casts. Hemoglobin 11 gm. A/G ratio 4.5/2.4. Nonprotein nitrogen 60. Creatinine 1.4. Phenolsulfonphthalein 28 per cent in two hours. Creatinine clearance—blood level 3 mg. per cent. Urine output 150 cc. Intravenous urogram, February 8, 1951, showed no evidence of the contrast medium in either kidney, indicative of poorly functioning kidneys. No reaction following injection.

Course. Good diuresis after mercurials; slow digitalization. Weight loss, 16 pounds. Status only slightly improved.

Diagnosis. Chronic diffuse glomerulonephritis, hypertensive arteriosclerotic heart disease, enlarged heart, congestive heart failure, Class III c.

Case II. N.M. First admission of nineteen year old colored male with six months' history of weakness, loss of weight, fever, and chills. Treatment elsewhere with penicillin had been unsuccessful; temperature remained at 102°F. and the patient continued to lose weight.

Examination. Temperature on admission 102°F.; pulse 110; respirations 30; blood pressure 130/70. A chronically ill patient who had been so for six months. Cervical, axillary, inguinal, and epitrochlear nodes palpable. Chest symmetrical. Dullness and diminished breath sounds at base of both lungs. Neck nodes had developed one month prior to admission. Weight loss in six months had been 25 pounds.

Physical examination negative. Eyes, ears, nose, and throat negative. Heart p2>a2. Abdomen negative.

Chest film revealed wide mediastinum probably due to enlarged hilar nodes with bilateral pleural effusion. Tap revealed 50 cc. straw-colored fluid. Sp. gr. 1.017. Negative for acid fast bacilli. Biopsy of lymph node revealed tuberculosis.

No abnormality of urinary tract shown by intravenous urogram. Visualization excellent. No reaction following injection.

The patient received streptomycin and para-aminosalicylic acid for forty-two days with marked improvement, disappearance of fever, and 32 pound weight gain. Little change in adenopathy.

Laboratory Findings. Three cerebrospinal fluid examinations negative for acid fast bacilli. Five gastric examinations positive. Urine negative. Examination of blood showed 6,900 white blood cells, with 81 per cent polymorphonuclears, 13 per cent lymphocytes, and 5 per cent monocytes. Nonprotein nitrogen 28. Tuberculin test negative.

Diagnosis. Miliary tuberculosis.

Among the other patients with acute or chronic glomerulonephritis, a woman, aged fifty-five, suffering concomitantly from pneumonia showed no reaction, a boy, aged seven, complained of arm pain, 1 patient showed flushing, and the fourth no reaction. The many patients with nephritis or pyelonephritis were injected with no more serious reaction than those already noted which lasted no longer than five minutes. A five year old boy with chronic pyelonephritis and a four year old girl with cystitis and pyelonephritis showed no reaction. Other younger patients fared as well. A boy, aged one and a half years, with nephrosis, a girl eight and a half months old with a chronic urinary tract infection due to *E. coli*, a two year old boy with delayed filling of the kidney, and a three month old girl with extrophia of the bladder showed no untoward reaction to the drug.

Uremia, another listed contraindication, likewise proved no deterrent to intravenous

urography with neo-iopax. One woman, aged sixty-four, with a tentative diagnosis of uremia showed no adverse reaction to the injection. Neither did a man, aged forty, with both uremia and chronic pyelonephritis.

No particular precaution was observed in patients with tuberculosis at various sites in the body. Urography in these patients was as successful and apparently as devoid of hazard as in patients with diagnoses where the diagnostic procedure would be undertaken without hesitation.

Our results in all of the cases cited and in the many patients with severe systemic diseases, with carcinoma, tumor, arteriosclerotic heart disease, malignant hypertension, nephrosis, pneumonia, hepatitis, congestive heart failure, cerebral vascular accidents, etc., convince us that neo-iopax can be administered when required for urography despite the fact that the primary diagnosis may be among the so-called contraindications. Our belief that no true contraindications to the use of neo-iopax exist is shared by Kordan[11] who states: "With the probable exception of Neo-iopax these substances [contrast media] are contraindicated in cases of severe uremia, malignant hypertension with or without uremia, severe liver disease and nephritis."

SUMMARY AND CONCLUSIONS

Six hundred consecutive cases of intravenous urography with neo-iopax by the rapid injection method have been reported to substantiate previous reports of the innocuous character of this drug. In no case was a serious reaction encountered during the thirty minute observation period following injection. A great many different diagnoses are found among the cases presented including those such as uremia and nephritis which formerly were thought to represent contraindications. Two such case histories are presented. Age was no criterion. Many of the patients were aged over seventy and eighty, others were under two years of age. From our experience over a period of four years, during which several thousands of patients have undergone urography by rapid injection, we believe that neo-iopax has proved to be exceptionally efficient, convenient, and safe to both the patient and the radiologist.

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IMMEDIATE HYSTERECTOMY FOLLOWING IRRADIATION FOR CARCINOMA OF THE UTERINE FUNDUS

A PRELIMINARY REPORT

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EXPERIENCED cancer therapists agree that the primary treatment of carcinoma of the corpus of the uterus is surgical removal of the organ in those patients who are adequate operative risks. It is also quite universally agreed that preoperative irradiation is desirable, preferably in the form of intrauterine applications of radium.

The hazards of delay between the intrauterine application of the radium and the surgical removal of the uterus must have occurred to many surgeons and radiation therapists. The delay in most instances is a period of from six to nine weeks, a period in which the irradiation action has been allowed to run its course before surgery is performed. This delay has become a standard procedure, as experienced surgeons have learned of the difficulties in operating in a field that is undergoing irradiation reaction.

Approximately two years ago we suggested to a gynecologist the feasibility of surgical removal of the uterus within twenty-four to thirty-six hours following the removal of the intrauterine radium. This suggestion was made with the thought that, if the uterus were removed within this period of time, the irradiation reaction would not have had time to manifest itself either grossly or histopathologically, and therefore would not present any problem to the surgeon. It was further thought that by the time the irradiation reaction was at its height in the remaining operative field, wound healing would be sufficient to cause no undue concern. This was confirmed by the ease of the surgical procedure made possible by the absence of irradiation reaction and the lack of postoperative complications that might be caused from the irradiation.

In this method of treatment the patient is hospitalized, and a tandem containing radon is inserted into the uterine cavity. The tandem consists of two brass tubes, each of 1.1 mm. filtration thickness and 4 cm. active length. The active ends are separated by a distance of 8 mm. Into each brass tube is inserted a platinum sleeve of 0.5 mm. filtration thickness, containing 55–60 millicuries of radon in a glass tube. The tandem, therefore, has a total strength of 110–120 millicuries of radon. Using radon decay tables, the period of time necessary to deliver a dose of 5,000–5,500 millicurie hours is calculated. The dosage varies somewhat with the estimated size of the uterine cavity, and extent of the tumor. The operation is performed twenty-four to thirty-six hours after removal of the tandem. Whenever the tumor was found to have invaded the myometrium or beyond, external irradiation through two anterior and two posterior pelvic portals was administered one to two weeks following operation. A total of 1,800 to 2,400 roentgens (air), depending on the size of the patient, was given to each portal at the rate of 200 r per day. Technical factors were: 400 kv. (peak), Thoraeus filter with half-value layer of 3.62 mm. Cu, 5 ma., 70 cm. target-skin distance.

SUMMARY OF CASE REPORTS

In the past two years, a total of 20 patients have been treated with this method. Two of these patients have died with extensive intra-abdominal metastases. One of these had multiple peritoneal implants at operation. The other patient had no apparent extension of the tumor at operation, but two months later was found to have a pelvic mass. Beginning at this time, she was given a total dose of 2,000 r (air) to each of four pelvic portals. Her condition became steadily retrogressive, and she died five

months postoperatively. Permission for autopsy was refused in both cases.

Two patients were found to have multiple peritoneal implants at operation, one at one and a half years ago, the other at one year ago. Each was given a total of 2,400 r (air) to each of the four pelvic portals beginning four weeks postoperatively. Both have palpable masses in the pelvis at present, and both are beginning to pursue retrogressive courses.

Two patients were found to have invasion of the myometrium. One was given a total of 2,000 r to each of four pelvic portals postoperatively, and to date, one and a half years later, has shown no evidence of recurrence of the tumor. The other patient did not return for postoperative irradiation, and we have not been able as yet to get in touch with her. The remaining 14 cases are alive and well, and no evidence of recurrent lesion was found at their last follow-up examinations.

DISCUSSION

It is difficult to ascertain, with any degree of certainty, the danger involved in delaying the removal of the uterus and adnexa in endometrial carcinoma from the standpoint of tumor cell metastasis and increase in the growth of the tumor itself. One may reason that possibly hours or minutes may be of importance. The delay of weeks in treatment of malignancy in other locations in the body is generally deemed poor practice. It would not, therefore, seem good practice to delay surgical removal in carcinoma of the body of the uterus once the diagnosis has been made.

There are two main reasons for the use of preoperative irradiation in carcinoma of the body of the uterus. One is the sterilization of malignant cells that may be spilled into the wound, the pelvis, or into vascular or lymphatic channels during the surgical procedure. The other is the hope that a cancerocidal dose of radiation may be given to malignant cells which already lie outside the immediate confines of the uterus, and are not in the operative specimen.

The thought has been advanced by some of our colleagues that the delay is necessary to obtain adequate irradiation effect on the malignant cells. It seems very logical to us that, in the dosage ranges used in the above cases, when the source of ionizing radiation is removed, certain irreversible changes have been produced in the malignant cells which lead to their destruction, regardless of whether they are left in the body or removed. It is doubtful that the possible transplantation of cells, by inadvertent spillage, into the previously irradiated pelvic cavity from whence they came is a significant factor because the potential tumor bed has already been irradiated, cutting down the chance of successful transplantation.

It is common knowledge that definite gross and histopathologic evidence of irradiation injury takes from six to ten days to make itself evident in tissue. We see no reason why gross and histopathologic changes must occur in the irradiated tissues before they can be removed.

It has been stated that one of the advantages of preoperative irradiation is its value in sealing off lymphatic and vascular channels as avenues of metastasis. If this is a factor in the preoperative use of irradiation, then the immediate surgery plan, as we have presented it, would be at a disadvantage, as a longer time factor would be necessary to destroy these channels.

As a rule, the surgeons have found the technical procedure less difficult with the immediate hysterectomy than with delayed operation; even at nine to ten weeks enough residual irradiation reaction may be present to complicate the operation. There has been no histopathologic evidence of irradiation changes in any of the surgical specimens from the above cases.

The most immediate advantage of this method is the reduced morbidity in the patients during the postoperative period. In no patient were any complications attributable to irradiation encountered. The courses of patients without extension of the tumor were uniformly smooth. This is in contrast to the potential stormy course following surgical procedure in an inflam-

matory pelvic field, such as is present six to ten weeks following irradiation.

An additional advantage is that postoperative roentgen irradiation, if desired, may be instituted sooner than would be possible when surgery is delayed.

We have purposely avoided a detailed discussion of the various techniques in dosage and types of applicators in the uterine irradiation, as there is much in the literature on this subject, and it is not the concern of this paper. No significant change from routine techniques has been used in this series so far as radium therapy itself is concerned.

SUMMARY

This is a report of twenty patients with carcinoma of the body of the uterus who have been treated with preoperative intrauterine application, and hysterectomy within twenty-four to thirty-six hours. The reasons for the use of this procedure have been discussed.

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THE USE OF COBALT 60 IN GAMMA-RAY THERAPY*

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I. INTRODUCTION

IN SEARCHING among the artificial radioactive isotopes for an alternative gamma-ray source comparable to radium in its radiotherapeutic applications, the qualities of Co^{60} were soon appreciated, especially the possibility of obtaining telecurie sources of ten, one hundred or even several hundred times the strength of radium telecurie apparatus now existing. This use of Co^{60} has been examined in some detail by Coliez,[4] Mayneord,[19] and others (unpublished data), and will not be considered here further.

The mechanical as well as radiation properties of Co^{60}, however, make it equally suitable for interstitial or surface, including cavitary, therapy. This paper is confined to the use of Co^{60} in solid form and a discussion of Co^{60} in solution for intracavitary therapy is therefore excluded.

II. PRODUCTION OF Co^{60} AND ITS DECAY SCHEME

Cobalt 60 was first produced from the stable isotope Co^{59} by the use of the then newly discovered neutron which was itself generated by the bombardment of Be with the alpha rays of radium.[1,35,37,38] Before the introduction of the nuclear reactors other modes of production have included also the Co^{59} (d, p) Co^{60} and Ni^{62} (d, α) Co^{60} reactions for the 5.3 year isomer and the Ni^{60} (n, p) Co^{60} reaction for the 10.7 minute isomer.[17] At this time the radiation physics of Co^{60} was fairly well established; the isomerism as well as the decay scheme and energies involved had been recognized. Co^{60} can now be produced in the chain reacting pile from Co^{59} by neutron bombardment in quantities sufficient to cover all likely demands. A wire of pure cobalt or an alloy of cobalt and nickel is irradiated for use in interstitial therapy or other small radiation sources.

The decay scheme of Deutsch, Elliott and Roberts[8] is shown in Figure 1. Beta-ray

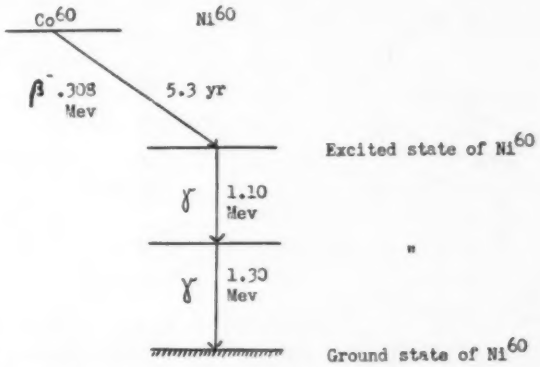


FIG. 1. Decay scheme of Co^{60} (after Deutsch, Elliott and Roberts[8]).

emission of maximum energy $.308 \pm 0.008$ mev.[23] is followed by the emission in cascade of two γ-ray quanta of 1.10 and 1.30 mev., or, as the latest measurements[28] suggest, 1.169 and 1.331 mev. It is this γ-ray emission combined with the comparatively long half-life and the easy production of Co^{60} which make Co^{60} one, if not the, most useful and practical, artificially radioactive γ-ray source. Other artificial γ-ray emitters with half-lives of ninety-seven days at the most—Ta^{182}—and γ-ray energies of up to 2.04 mev.—La^{140} which is in transient equilibrium with another γ-ray emitter Ba^{140}—have been considered by Mitchell[23] and Mayneord.[19]

The other radioactive isotopes of cobalt of which six or seven are known at present are with their much shorter half-lives and

* This investigation was aided by a grant from the Damon Runyon Memorial Fund for Cancer Research

their lesser, if any, γ-ray activity, mostly unsuitable for this kind of therapy.

III. INTERSTITIAL Co^{60} SOURCES

Myers[25] has used an alloy of cobalt and nickel ("cobanic," containing 45 per cent cobalt and 55 per cent nickel). The radio-nickel produced during irradiation in the pile does not contribute significantly to the radioactivity of the sample. Callendine, Morton and Myers [2,24] have recently presented a method of using an assembly of Co^{60} seeds as interstitial sources which are carried in hollow nylon thread. Meschan, Edwards and Rosenbaum[21] have described the use of 16 gauge hyperchrome steel tubing with an over-all diameter of 1.65 mm. as a sheath for cobalt wire; in this way, they are able to reduce the inactive ends to 0.2 cm. by crushing one, and silver soldering the other end.

The Chicago Tumor Institute has been in possession of Co^{60} interstitial sources since April, 1949. Cobalt element in the form of 1 mm. diameter wire, supplied by the Argonne National Laboratory, Chicago, was irradiated by the Isotopes Division, U. S. Atomic Energy Commission, to produce an activity of about 1 mc. per cm. The wire was then cut into lengths of 1, 2, and 3 cm. which were inserted into 0.3 mm. steel needles* of appropriate lengths and sealed. This whole process of assembly was carried out by the Isotopes Division, U. S. Atomic Energy Commission, after they had devised means of operation by remote control. It is now available for general use as announced in their catalogue (No. 3).[15]

The activities of the individual needles were kindly measured by Dr. L. F. Curtiss at the National Bureau of Standards and were found to vary by about 1.5 to 3 per cent from the average of their group except for one particular needle which was more than 6 per cent weaker. The average group activities were 1.23, 2.39, and 3.46 mc. for the 1, 2, and 3 cm. active lengths respectively, 1 mc. being the amount of nuclide in which there are 3.7×10^7 disintegrations per second. The stainless steel needles were made in three parts (see Fig. 2) to specifications insuring their similarity with our radium needles. They therefore have with 6.0–6.5 mm. fairly long inactive ends in their total lengths averaging 23, 33.1, and 42 mm. for the three different strengths. The outer diameters vary from 1.61 to 1.65 mm.

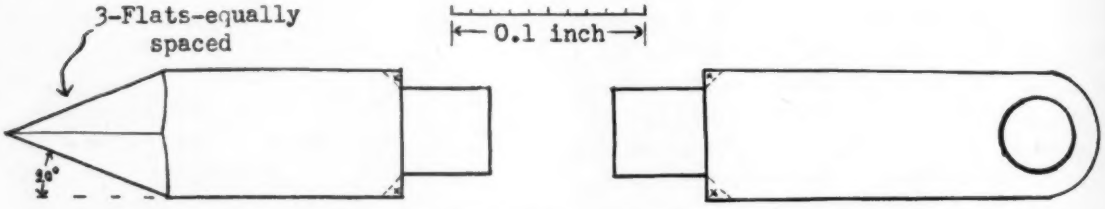


FIG. 2. Point and eye ends of 0.3 mm. stainless steel needle. (It has been suggested that the corners marked * be cut off to allow room for soldering material.)

The use of Co^{60} as a substitute for radium is open to a great variety of modifications. The many problems associated with the packing of radium needles and tubes involving powders to be filled into capillary tubes and the difficulty of insuring uniform packing no longer exist when dealing with solid lengths of radioactive material. The degree of uniformity of distribution of Co^{60} atoms in neutron-irradiated cobalt wire will have to be examined but is not likely to be much in question when regarded from the point of view of distribution along the length of the wire. In depth there will be a differential effect leading to a massing of radioactive atoms in the surface layers ac-

* Supplied by Mr. L. P. Niemiec, Benthloe, Inc., 1506 West Huron Street, Chicago 22, Illinois.

cording to Dunning *et al.*[9] This latter effect, however, should have little influence on the dose distribution around the source as a whole.

Filtration. In contrast to radium which gives off high energy beta particles (the maximum being RaC-β of 3.15 mev.) and therefore requires heavy filtration, the β-ray energy of Co^{60} with its maximum of 0.308 mev. and a mean energy of only about 0.1 mev. has a maximum range of 80 mg./cm.^{2} in Al. This corresponds to thicknesses of 0.11 mm. steel, 0.1 mm. nickel or silver, or 0.05 mm. gold. Electroplating of the cobalt wire with one of these elements has been suggested by, among others, Myers[25] and Mayneord.[19]

The aim of this protective layer would be twofold: first, as a filter for radiation and secondly, it would allow such an electroplated cobalt wire to be introduced directly into the tissues without fear of absorption of cobalt which is highly toxic to the central nervous system and intestinal canal (where it is probably excreted). That cobalt can be absorbed into the tissues when introduced in metallic form was shown recently by Nickson *et al.*[27] The choice of plating material equally depends on various factors: the metal chosen must be noncorrosive and inabsorbable in tissue fluids or at least nontoxic. On the other hand, as pointed out by Mr. J. E. Rose, it is most desirable to do the electroplating on the "cold" wire, *i.e.*, before its exposure to the neutron stream; and therefore the activity induced in the plating material must have certain characteristics. The most important of these is a short half-life, allowing, by the use of a certain cooling-off period of the order of 10 half-lives (by which time the activity is down to 0.1 per cent), rapid disappearance of this unwanted activity without significantly affecting the activity of the cobalt 60 itself.

Of the materials listed by Mayneord,[19] rhodium and gold seem particularly useful from this point of view (half-lives of 36 hours and 2.7 days respectively); platinum, too, might be considered (T=18 hr.). Silver and chromium would be rather unsuitable, especially the latter, unless the activity to be expected can be neglected (see below). Nickel with its long half-life of sixteen years might be considered only because the β-emission associated with its K-capture showing an energy of 50 kev. will be absorbed by a maximum of 50μ of tissue and the β-particles with the mean energy of 16 kev. by 6μ of tissue, *i.e.*, the first cell layer approximately. There remains, however, the problem of handling these sources.

Another consideration governing the choice of electroplating material, but because of their greater thickness more important with actual metal sheaths, is the question of secondary radiation. Elements listed by Quimby *et al.*[33] as giving rise to the minimum amount of secondary β-radiation should be used if at all possible.

The activities produced in the electroplated metals vary by factors of almost 10^6 between a 0.05 mm. layer of gold and a 0.1 mm. layer of steel, with nickel somewhere in the middle, due in part to the varying half-lives, but mainly because of the differences in activation cross sections ($\sigma_{Au}=96$, $\sigma_{Fe}=0.0017$).[42] After a month's irradiation, at a flux of 5×10^{11} neutrons /cm.^{2}/sec., and assuming all aspects of the wire are equally exposed which may not actually be the case, the 0.05 mm. layer of gold (including the ends) will contain from 18 to 42 mc. Au^{198} according to variation in length of the cobalt wire from 1 to 3 cm. Corresponding figures for 0.10 mm. layers of nickel and steel are 7 to 16 μc. of Ni^{59} and 0.32 to 0.75 μc. of Fe^{59}. The gold will decay to an activity of 8.2 to 19.2 μc. in one and 2.9–6.6 mμc. (millimicrocuries) in two months "cooling off." These activities can be regarded as negligible from the point of view of additional irradiation within tissues but not necessarily for purposes of handling the wire. The nickel will lose only about 4 per cent in one year, the steel's activity will have been reduced to 1.3 to 3.1 mμc. in one year.

Secondary Radiation Induced in Sheath.

If we want to compare this with the activity induced by the Co^{60} photons in our 0.3 mm. steel envelopes, we shall make certain assumptions for the care of simplicity, specifying as a first approximation that most of these photons—of an average

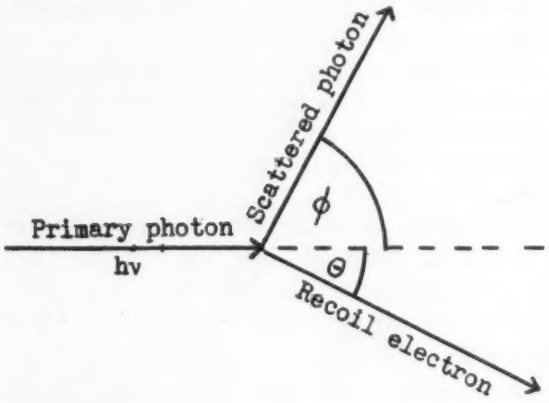


FIG. 3. Compton (recoil) electron moving at an angle $\theta = 27°$ when scattered photon is deflected at an angle $\phi = 60°$ for $h\nu$ of primary photon = 1.234 mev. (average energy of Co^{60} γ-ray photons).

energy of 1.23 mev.—originate in the periphery of the cobalt wire. According to Mayneord and Cipriani[20] the mass absorption coefficient for Co^{60} γ-rays in steel is 0.0538, giving a linear absorption coeff. $\mu_l = 0.420$ (for a density of 7.8). This means a total absorption of 1.25 per cent in 0.3 mm. On the other hand, according to Wilson,[43] at the wavelength in question $\lambda_{av.}$ $Co^{60} = 10$ X.U. the electronic absorption coefficients are ${}_e\sigma_a$ (for true absorption by scattering) $= 0.9 \times 10^{-25}$/cm.^{2} and ${}_e\sigma_s$ (scattering abs.) $= 1.0 \times 10^{-25}$/cm.^{2} From these the total scattering abs. coeff. $\sigma_{Fe} = 0.415$ cm^{-1}. As $\mu_{Fe} = 0.420$ (see above) only about 1 per cent of the absorption appears to be due to photoelectron production at this wavelength.

Nine-nineteenths of the absorption is due to the production of recoil (Compton) electrons, *i.e.*, 0.6 per cent of the γ-ray energy emitted by the cobalt 60 wire is transferred to these electrons. In other words, if we consider 1 mc. of Co^{60} from which $2 \times 3.7 \times 10^7$ γ-ray photons of an average energy of 1.23 mev. are issuing per second, these will produce in the part of the steel envelope under which they originate 1.81×10^4 photoelectrons/sec. (of 1.23 mev.) $+ 71.4 \times 10^4$ first order recoil electrons/sec., of varying energies and in varying directions, as well as a slightly larger number corresponding to the absorption of the rest of the photon "corona" in the cobalt wire itself and part of the steel sheath on the opposite side of the needle (see Fig. 4). The energies and directions of the recoil electrons are, however, correlated with one another and with the direction of the scattered photon, as well as the energy of the original photons, according to quantum-mechanical considerations leading to the formulae

$$\cot \frac{\phi}{2} = -(1+\alpha) tg\, \theta \qquad (1)$$

and

$$E = h\nu \cdot \frac{2\alpha \cos^2 \theta}{(1+\alpha)^2 - \alpha^2 \cos^2 \theta} \qquad (2)$$

where ϕ is the angle through which the

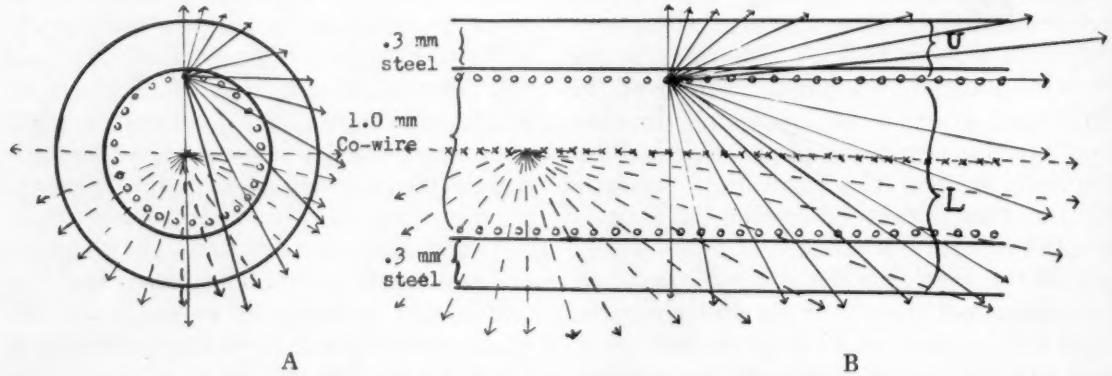


FIG. 4. Photon paths A: → and B: —·—→ (only 180° "corona" shown here) for two alternative positions of radiocobalt atoms (A: o, B: *) in cobalt wire.

modified photon is scattered, θ the angle at which the recoil electron moves (see Fig. 3),

$$\alpha = \frac{h\nu}{mc^2} = \frac{0.0243}{\lambda} \text{ } i.e., \text{ in our case,} \quad (3)$$

of $\lambda = 10$ X.U., $\alpha = 2.43$ (3), $h\nu$ = primary photon energy and λ its equivalent wavelength in A.U.

Compton and Hubbard[6] have worked out the probability $P\theta d\theta$ that the recoil electron will move at a certain angle to the path of the primary photon. The recoil electron will always have a forward component, as from (1) where ϕ may take up any value between 0° and 180°, θ will take values only from 90° to 0°. The energy of the recoil electron will be a maximum for $\theta = 0°$ *i.e.*, movement in the direction of the original photon, the scattered photon moving in the opposite direction ("backwards") when (2) reduces to $E_{max} = h\nu \cdot (2\alpha/1+2\alpha)$ and for $\lambda = .01$ A.U. or 10 X.U., $E_{max} = .83\ h\nu \sim 1$ mev. (the av. primary photon energy being 1.23 mev.).

The energies of the 1st order Compton electrons have been evaluated for certain angles of deflection from (2) and are shown in Table I. Table II compares ϕ, the angle of deflection of the scattered photon, with θ, the angle of the recoil electron according to formula (1). It shows how the recoil electrons whose corresponding scattered photons are deflected between 60° and 180° are compressed into the small angular region of 0–27°.

The fraction of 1st order recoil electrons moving within a range of angles can be calculated as the integral

$$\int_{\theta_1}^{\theta_2} P\theta d\theta = -3ab \int_{\theta_1}^{\theta_2} \frac{a^2 \tan^4\theta + b}{(a\tan^2\theta + b)^4} \cdot \frac{\sin\theta}{\cos^3\theta} d\theta \quad (4)$$

where

$a = (1+\alpha)^2$ and $b = (1+2\alpha)$ cf. formula (3)

and the values for the 15° intervals from 0° to 90° are presented in Table III together with experimental values obtained by Kirchner[16] and Compton.[5]

If we consider the production of recoil electrons in the cobalt wire and steel sheath from the point of view of spatial distribution, we shall again have to make certain assumptions. In Figure 4 we can assume the radioactive cobalt atoms for the purposes of this calculation to be either (A) in the periphery of the cobalt wire or (B) in its center—in reality they appear to be distributed throughout the wire somewhat nonuniformly, namely with some crowding in the outer layers. The γ-ray photons will be emitted as a "corona" in all possible directions of space and only those lying in

Table I

Energy and range of first order Compton electrons and of the photoelectrons elicited by Co^{60} photons ($\lambda = 10$ X.U.)

θ	Energy	Maximum Range* in Steel	Tissue
	Compton electrons		
0°	1 mev.	0.55 mm.	4.1 mm.
15°	.9 mev.	0.455 mm.	3.6 mm.
30°	.612 mev.	0.29 mm.	2.1 mm.
45°	.330 mev.	0.115 mm.	0.9 mm.
60°	.146 mev.	0.032 mm.	0.25 mm.
75°	.0355 mev.	0.003 mm.	—
82°	.010 mev.	0.00026 mm.	—
89°	.000155 mev.	—	—
90°	0	—	—
	Photoelectrons		
	1.23 mev.	0.633 mm.	5.35 mm.

* The maximum ranges have been evaluated from the graphs presented by Morgan, G. W., in "Some Practical Considerations in Radiation Shielding." Isotopes Division Circular B-4. November, 1948.

Table II

Corresponding scattering angles of photon (ϕ) and recoil electron (θ). (primary photon $\lambda = 10$ X.U.)

ϕ	θ
0°	90°
15°	65½°
30°	47½°
45°	35°
60°	27°
75°	21°
90°	16½°
120°	9½°
150°	4° 15′
180°	0°

TABLE III

FRACTION OF COMPTON ELECTRONS MOVING WITHIN A CERTAIN ANGULAR RANGE

	Calculated from (4) for $\lambda=0.010$ A.U. (Co^{60})	Calculated from Kirchner's[16] Experimental Values $\lambda=0.13$ A.U.	Estimated from Fig. III.-4, Compton and Allison[5] (p. 125) $\lambda=0.017$ A.U. in Iron
0°–15°	17.10%	21%	ca. 55%
15°–30°	35.9%	28%	
30°–45°	10.2%	20%	
45°–60°	9.8%	12%	
60°–75°	11.3%	7%	
75°–90°	15.8%	12%	

the plane containing the central axis of the needle can be shown in Figure 4. One will not go far wrong, however, in considering only this spread and to calculate the average path length therefrom. Under assumption (A) this is 0.1 cm. for the photons entering the adjacent steel sheath directly (part U of corona in Fig. 4) and 0.4 cm. for the photons entering the cobalt wire for however short a distance before emerging into the lower part of the steel sheath (part L of corona in Fig. 4). For assumption (B) the average photon path length is 0.267 cm. From these average path lengths the absorption and therewith number of photoelectrons and 1st order recoil electrons can be calculated by means of the scattering and photoelectric absorption coefficients; only a slight error will be introduced because of the use of the average path lengths.

Next let us consider Figure 5 in which a recoil electron is produced at point P by the photon moving at an angle δ to the main axis of the needle. The probability of any primary recoil electron escaping from the needle will depend on (1) the position of the point P in relation to (a) its distance from the surface, (b) its distance from one end of the needle, (2) the angle of the photon, (3) the angle of the recoil electron and therewith the energy with which it proceeds (θ, E) expressible as the probability $P\theta d\theta$ (Table III), and (4) whether the angle has a positive or negative value.

The path length z of the recoil electron within the steel sheath, presuming it to be straight, is related to the distance of P from the surface as follows:

$$z' = y \sec. [90° - (\delta + \theta)] \quad (5)$$

$$z'' = y \sec. [90° - (\delta - \theta)] \quad (6)$$

Using the range of recoil electrons of a

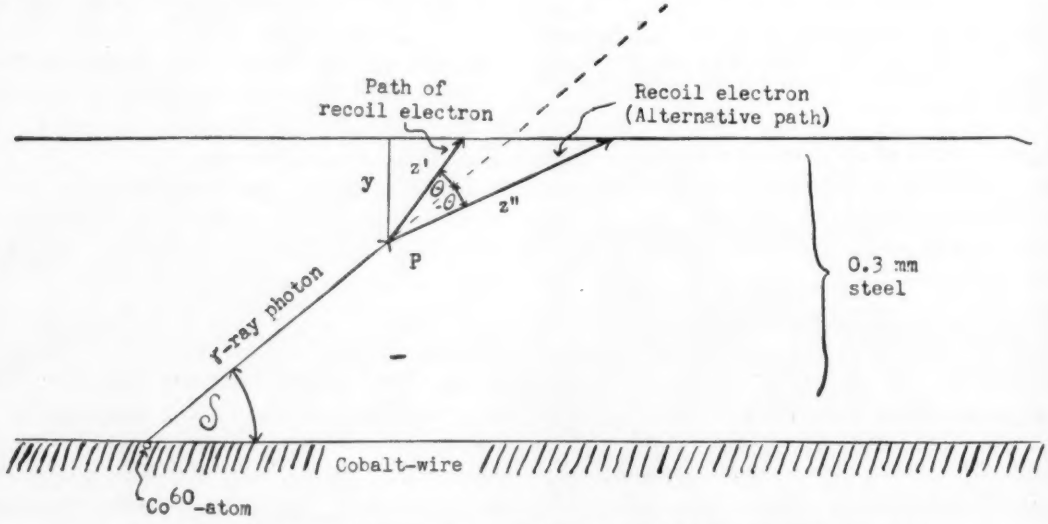


FIG. 5. Origin of recoil electrons in steel sheaths with their alternative paths z' and z'' in plane of primary photon and main axis of needle.

certain angle as the maximum possible path it can travel, the possibility of a recoil electron to escape from the needle when it is produced within a certain layer of steel envelope by a photon travelling at a certain range of angles can then be calculated. When all these values are collected and summated, and assuming further (1) that the recoil electrons are produced "at random" over the total possible path length of all photons, (2) that all primary recoil electrons that have a "geometrical" chance to escape from the needle do so, with a similar approximation for photoelectrons, and (3) taking the absorption coefficient in cobalt to be equal to that of steel, the following facts emerge: Under assumption (A)

43.5×10^4 recoil and photoelectrons escape per second and under assumption (B)

27.5×10^4 do so.

If there are no others—and they are likely to be insignificant in energy if not in number, and not forgetting that the scattered photons may yet produce further recoil and even photoelectrons—the approximate number of β-rays emerging from the surface of a 1 cm. active needle (2 cm. total length) is of the order of 35×10^4 per sec. per mc. Co^{60} or, in other words, the needle has a β-ray activity corresponding to a source of 35 μc. per mc. of Co^{60}.

Linear Intensity. It has been announced[15] that one month's irradiation of a 1 mm. cobalt wire will produce an activity of about 2 mc. per cm. In interstitial therapy the tendency has been towards weaker and weaker sources following Paterson and Parker[30] ideas, and it should be easy by a program of regular replacements to collect over the years a variety of Co^{60} sources with different linear intensities. Our radium stock at the Chicago Tumor Institute has a linear intensity of 1 mg. per cm. so that we need sources with 0.5 mg. or its equivalent per cm. in order to carry out Paterson-Parker implants properly. In terms of Co^{60} that will mean 0.3 mc. per cm. For stock of the Manchester type itself, *i.e.*, linear intensities of 0.6 and 0.3 mg. per cm., the corresponding values for Co^{60} are 0.37 and 0.185 mc. In view of the decay of Co^{60} it may be advantageous to start off with somewhat higher intensities; the weaker of these two types will become practically unusable after about two years, the stronger line can after a time be used together with 1 mg. per cm. radium stock and later as the weaker member of a newly acquired 0.37 mc. per cm. line. The useful life starting out with, say, 0.5 mc. per cm. might be about eight years by which time about 35 per cent activity remains, *i.e.*, 0.175 mc. per cm. or 0.281 mg. Ra-equivalent per cm.

The neutron irradiation time necessary for such weak sources is extremely short: linear intensities of 0.369 and 0.1846 mc. per cm. require only $2\frac{1}{3}$ and $4\frac{3}{4}$ days, re-

TABLE IV

ACTIVITIES PRESENT IN SHEATHING LAYERS OF 1 CM. ACTIVE Co^{60} SOURCES AT VARIOUS TIME INTERVALS AFTER NEUTRON IRRADIATION FOR $2\frac{1}{3}$ AND $4\frac{3}{4}$ DAYS

	Neutron irradiated electroplated layer						0.3 mm. steel sheath	
	0.05 mm. Au		0.10 mm. Ni		0.10 mm. Fe			
Co^{60} content	0.185 mc.	0.37 mc.	0.185 mc.	0.37 cm.	0.185 mc.	0.37 mc.	0.185 mc.	0.37 mc.
Initial strength	8.1 mc. Au^{198}	12.7 mc. Au^{198}	0.56 μc. Ni^{59}	1.12 μc. Ni^{59}	30 mμc. Fe^{59}	60 mμc. Fe^{59}	6.47 μc.-eq.	12.94 μc.-eq.
After 30 days	3.7 μc. Au^{198}	5.75 μc. Au^{198}	.558 μc. Ni^{59}	1.116 μc. Ni^{59}	19 mμc. Fe^{59}	38 mμc. Fe^{59}	6.40 μc.-eq.	12.8 μc.-eq.
After 61 days	1.3 mμc. Au^{198}	2.0 mμc. Au^{198}	.556 μc. Ni^{59}	1.112 μc. Ni^{59}	13 mμc. Fe^{59}	26 mμc. Fe^{59}	6.33 μc.-eq.	12.66 μc.-eq.
After 6 months	—	—	.547 μc. Ni^{59}	1.094 μc. Ni^{59}	1.9 mμc. Fe^{59}	3.8 mμc. Fe^{59}	6.06 μc.-eq.	12.12 μc.-eq.
After 1 year	—	—	.535 μc. Ni^{59}	1.07 μc. Ni^{59}	0.12 mμc. Fe^{59}	0.24 mμc. Fe^{59}	5.68 μc.-eq.	11.36 μc.-eq.

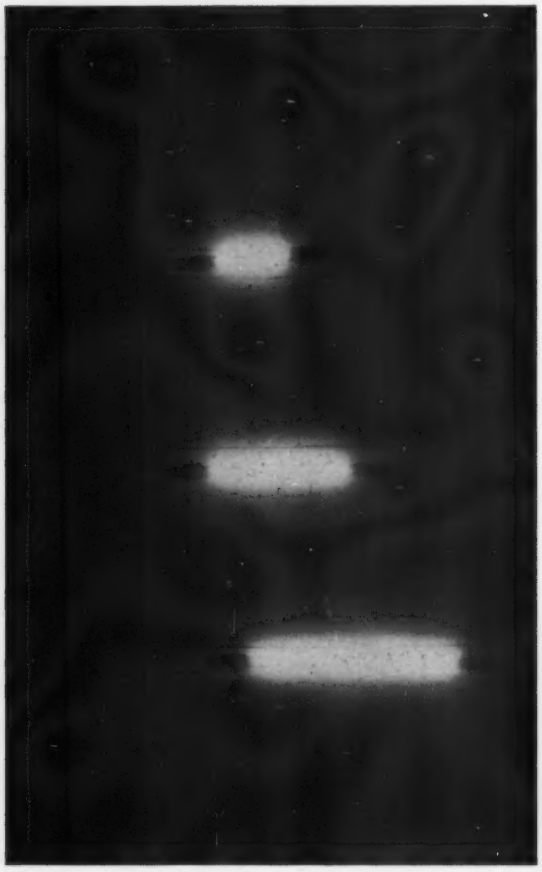


FIG. 6. Radioautographs of Co^{60} needles (0.3 mm. stainless steel sheath): 1, 2, and 3 mc. Exposure 30 sec.+short exposure to red light.

spectively, in a nuclear reactor that produces a specific activity of 2 mc. per cm. in one month.

In Table IV I have collected the activities present in the electroplated layer around cobalt wire 1 cm. long under these circumstances as well as the (secondary) β-ray activity of comparable 0.3 mm. steel sheath needles, the latter naturally decaying with the Co^{60} itself.

An approximate calculation shows that the *secondary* radiation issuing from the electroplated preparations in the case of 0.1 mm. Ni or Fe is of the order of 80 per cent of that coming from the 0.3 mm. steel needles, corresponding to at least 10 times the rate of disintegration of the nickel and over 1,000 times that of the iron layer; with time, the secondary radiation becomes the preponderating factor still more so, including the gold-plated specimen. Neary[26] has shown for radium that "for needles or flat applicators of 0.5 mm. platinum screenage, the ionization of the primary beta radiation in the adjacent tissue is never more than a few per cent, and is in any case much less than the ionization of the secondary beta radiation from the filter." A calculation of the absolute value in the case of radium preparations with its complicated β- and γ-ray spectrum is beyond the scope of this paper.

Radioautographs. Radioautographs of the cobalt 60 needles and some of our radium needles, using in the main the technique described by the late Dorothy F. Clephan[3] in 1945 are presented in Figures 6 to 10. We have found that with the use of Kodak

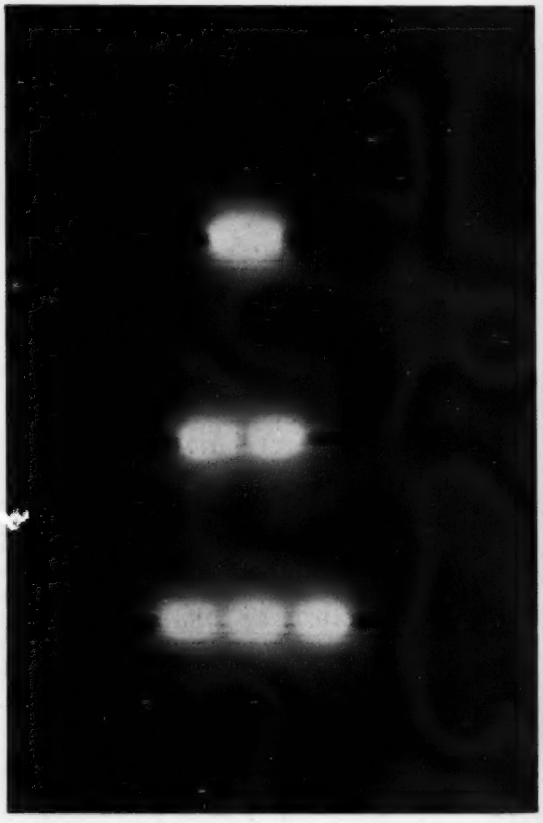


FIG. 7. Radioautographs of radium needles: 1 mg. in 0.2 mm. Pt cell+0.325 mm. monel sheath needle; 2.2 mg. and 3.1 mg. needles with total filtration of 0.5 mm. Pt. Exposure 45 sec.+short exposure to red light.

Blue Red roentgen film an exposure to a 10 watt red-painted bulb for about 2/5 second was sufficient to produce a picture of the body of the needle itself without destroying the detail of the radiation effect. The essential similarity of radioautographs of our radium and cobalt 60 needles compared in this way is most evident in the 1 mg. and 1 mc. needles, but is masked in the other strengths because of the multicell character of the radium needles. The uniformity of the Co^{60} sources which one would expect are well shown, especially in the films which were not exposed to light.

One interesting effect was noted with both Co^{60} and Ra needles: in Figures 8 and 9 an intense line can be seen on either side of the main imprint of the column of radioactive material. This is caused by the edge

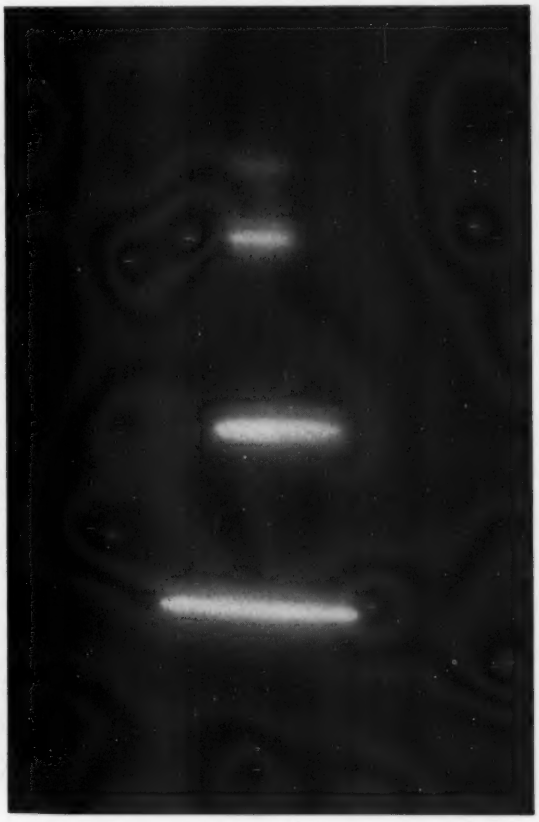


Fig. 8. Radioautographs of Co^{60} needles, lying in grooves cut out of washed film base. Exposure 10 sec. (without exposure to red light). Note: white lines on either side of needles except topmost where needle lay on top of film base for about 2 sec.

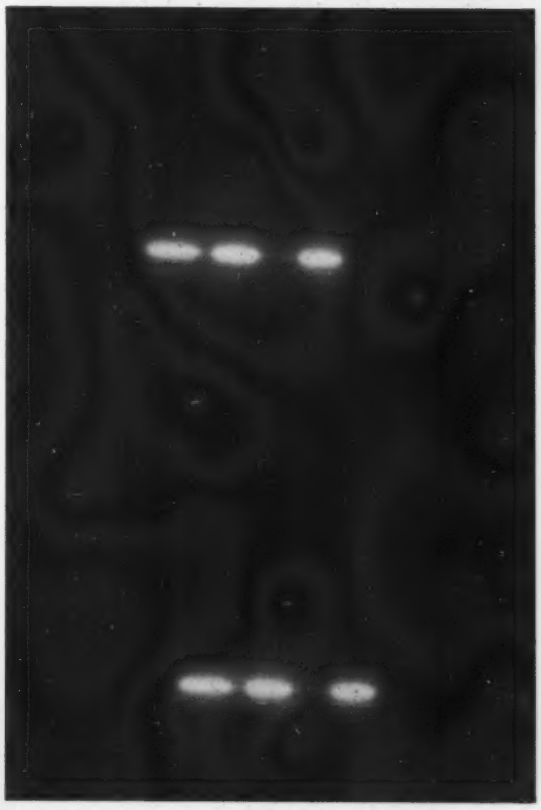


Fig. 9. Radioautographs of 3.1 mg. radium needles. Exposure 20 sec. (without exposure to red light). Above: needle lying without support on unwrapped film. (Note: arc lines on either side of needle where lead cylinders were standing.) Below: needle lying in groove of film base. Note: white lines (cf. Fig. 8).

of the cut-out in the washed film base used to keep the needles from rolling. The picture is representative of the transition effect in air at the surface of the film from the cut edge resulting from the impact of the secondary β-radiation on this boundary.

Differential Loading of Co^{60} Needles. The method of differential loading of radium needles in order to avoid the necessity of "closing" planar or volume implants after the method of Paterson and Parker [30] has been worked out by Stewart[41] but is not easy to carry out because of the difficulty and high cost involved in handling radium. A rather flexible modification has been evolved by Green,[12a] and Ellis,[10] too, has used radon-seed filled needles with differential loading. It should be fairly easy

to adopt a similar technique for linear Co^{60} sources which may be made up to the desired specifications either permanently or for use with an individual case. The latter procedure would involve stocking naked Co^{60} wire of varying lengths and linear intensities which could be filled into sheaths at the required time if the necessary apparatus and protection could be made available.

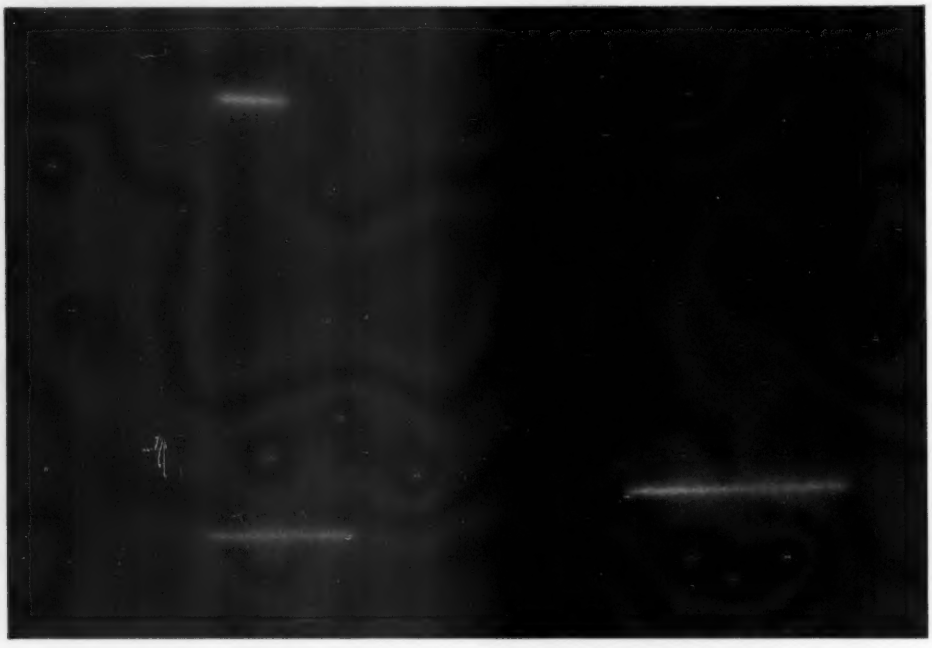


FIG. 10. Radioautographs of Co^{60} needles lying unsupported (cf. Fig. 8 and 9). Exposure 5 sec. (without exposure to red light).

Decay Constants of Co^{60}. Co^{60} as it is obtained in the pile by neutron capture from the stable isotope Co^{59}, exists in two forms, one decaying with a half-life of 10.7 minutes, apparently changing by isomeric transition into the longer living 5.3 year isomer. The 10.7 min. isomer will have practically disappeared within a few hours and need not concern us here any further. The half-life of 5.3 years is comparatively long as artificial isotopes go but still inconveniently short when compared with radium, as sources will need revaluation at fairly short intervals. The half-life of 5.3 years (46,360 hr.) corresponds to a disintegration constant $\lambda = .13078_2$ year^{-1} $= 0.0109_0$ month^{-1} $= 0.000358_1$ day^{-1} $= .0000149_2$ hr.$^{-1}$ $= 4.1442 \times 10^{-9}$ sec.$^{-1}$. The average life is $\tau = 1/\lambda = 7.65$ yr. $= 2{,}800$ days (2,793 days). A decay table using these constants has been published by Myers.[25] The monthly decay amounts to 1.08 per cent, *i.e.*, 12.26 per cent a year. In three days 0.1 per cent is lost. Mayneord[19] suggests revaluating interstitial sources at least twice a year in order to avoid errors of much more than 5 per cent. Within the periods likely to be used in interstitial and surface as well as intracavitary therapy with Co^{60}, *i.e.*, one or two weeks, the sources can be regarded as constant therefore, without making an appreciable error and the Co^{60} mc. hr. used may be converted into "equivalent mg. hr." of Ra by the use of the appropriate factor. This factor, the ratio of the specific dose rates* of Co^{60} and Ra respectively is $13.5/8.4 = 1.607$ or 1.61 to two decimals. Some of the problems connected with the short half-life of Co^{60}

* The specific dose rate k is defined as the γ-ray emission measured in r per mc.hr. at 1 cm. from a point source, unfiltered except in the case of radium which is filtered through 0.5 mm. Pt.

are similar to those already solved for mesothorium, used—especially in Germany—as a substitute for radium.

Dose Determination. If the millicurie hour had not been adopted officially at the Sixth International Congress of Radiology in London,[14] where it appears in the unit for γ-ray emission, to be measured as r/mc.hr. at 1 cm., one might have suggested the term "cumulative mc.hr." with the symbol Σmc.hr.† for this unit, in order to avoid any ambiguity or make unnecessary a cross reference to radium such as is implied in the term "equivalent mg.hr. per initial mc." appearing in radon decay tables.

The actual cumulative mc.hr. value is obtained as follows: $\Sigma\text{mc.hr.} = N_{0/\lambda}(1\text{-}e^{-\lambda t})$ where N_0 the initial number of mc., and the time t and decay constant λ are expressed in hr. and hr.$^{-1}$ respectively. From the foregoing, as far as it refers to Co^{60}, one can see that—to take an extreme example—in making up 4,000 mc.hr. (say, necessary to deliver a dose of 1,000 r_γ to a certain area at a certain distance), one would be more or less correct in using 4,000 mc. of Co^{60} for 1 hr., 400 mc. for 10 hr. or even 40 mc. for 100 hr., and when using 4 mc. for 1,000 hr. (ca. 6 weeks) or 1 mc. for 4,000 hr. (ca. 5 months) (quite apart from the probable biological inefficiency), one would have given an r_γ dose low by only 0.74 per cent and 2.0 per cent respectively. In actual practice, therefore, one will be justified in neglecting Co^{60} decay in treatment times of one week or less, or even two weeks, considering the permissible variation of 10 per cent in the Paterson-Parker dosage schemes for instance.

The practical use of the millicurie destroyed as applied to Co^{60} is restricted to some long term experiments as it has a large value compared with the Rn mc.d.: 1 mc.d. $Co^{60} = 67.0_3 \times 10^3$ Σmc.hr. Its submultiple, the μc.d. equals 67 Σmc.hr. and may have more immediate applications. In terms of the equivalent mg.hr. of Ra, 1 μc.d. of Co^{60} equals 0.812 mc.d. of Rn and the decay of Co^{60} in one week is therefore found to correspond to 2.5 μc.d. per initial mc. (*i.e.*, 0.25 per cent), or 167.8 Σmc.hr. In one of our butter experiments (see IV below), where Co^{60} sources were left to act for as long as eight months, a 3.5 mc. source deteriorated to 3.21 mc., *i.e.*, .29 mc.d. were used or 19.43×10^3 Σmc.hr.

Dose Rate. The specific dose rate of Co^{60} is $k = 13.5$ r_γ per mc. per hr. (or somewhat higher at $6.56 + 7.34 = 13.9$ r_γ if the more recent values for the γ-ray energies are confirmed), *i.e.*, at 1 cm. without filtration, the source being a point source. This is $1.607 \times k_{Ra}$ a value which has been used throughout this paper but may have to be modified slightly later. (The spec. γ-ray dose rate is listed as I_γ by Marinelli, Quimby and Hine[18] but can also be read off as the sum of the i_γ values of the two photons from their Fig. 3 or Mayneord's[19] corresponding Fig. 52).

Absorption and Protection. As already mentioned, Mayneord and Cipriani[20] have published experimental values of the absorption coefficients of a number of metals regarding Co^{60} photons which are important not only for a consideration of the dose distribution with various container materials but also as regards protection. Making a detailed calculation involving the two photon energies separately, the Pb half-value layer is found to be 1.035–1.075 cm. according to the thickness of lead used, *i.e.*, about 12 per cent lower than for radium. This should be compared with Myers'[25] experimental value of 1.12 cm. Any vaults or safes suitable for radium can therefore be used just as well for Co^{60} provided that the total amount of γ-ray emitters does not surpass the critical value for the particular thickness of lead used.

Dose Distribution. It will be necessary to explore the dose distribution around any type of Co^{60} source in the same way in which radium sources have been investigated. From the published data on specific

† The nuclide referred to could be indicated by a superscript or in-script such as $\sum^{Co^{60}}$ mc.hr. or $\sum Co^{60}$ mc. hr. if the typographical difficulties can be overcome.

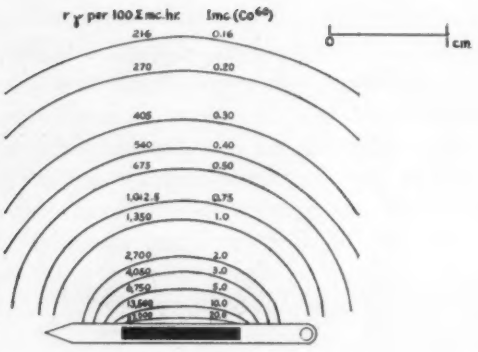


Fig. 11. 1 mc. needle.

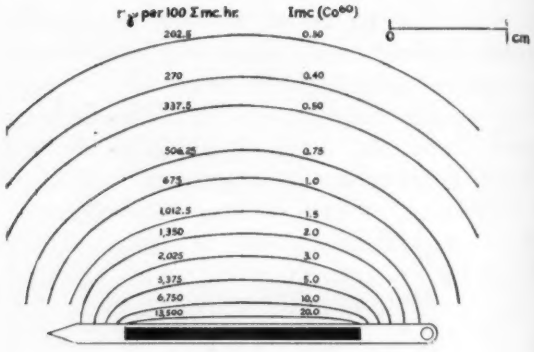


Fig. 12. 2 mc. needle.

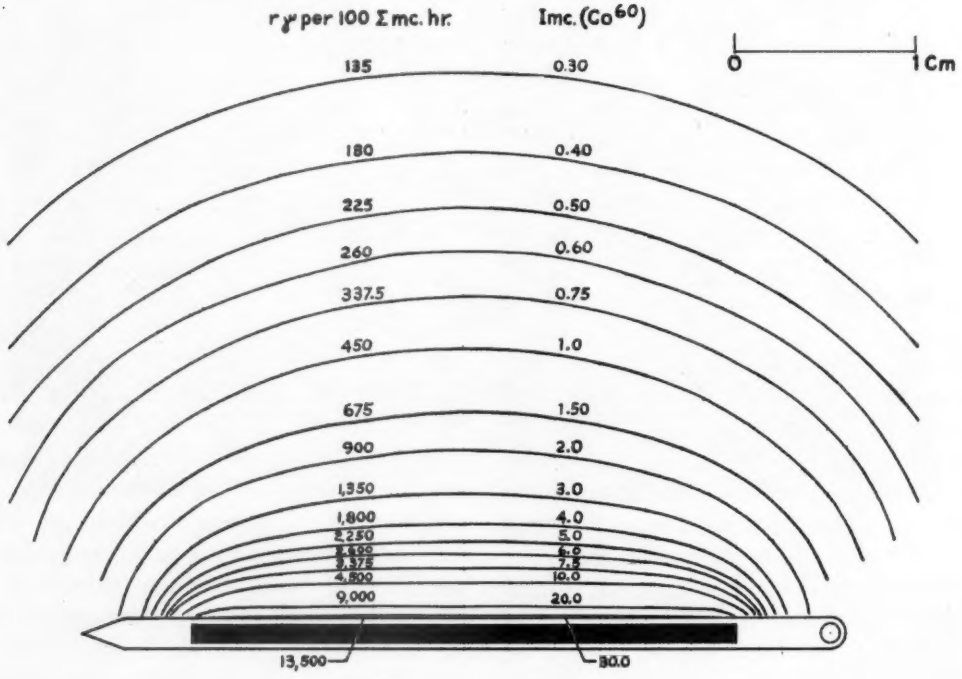


Fig. 13. 3 mc. needle.

FIG. 11–13. Calculated isodose (iso-intensity) curves of 0.3 mm. stainless steel needles containing irradiated cobalt wire. Intensity in Imc. (Co^{60}) for a linear intensity of $\rho = 1$ (1 mc. Co^{60} per cm. active length), r_γ per 100Σmc. hr. for $k = 13.50$.

dose rate and absorption, it is possible to convert existing tables, *e.g.*, Quimby's[32] coordinate system and Paterson-Parker[29] graphs of line sources for use with Co^{60}, but such calculations should probably be checked closely by other methods in view of the rather different makeup of Co^{60} sources as they exist at present and the much greater variety that is likely to be developed. The difference between a 0.5 mm. Pt radium needle and our 0.3 mm. steel needle as regards filtration and especially the amount of oblique filtration involved near and towards the ends of the source should produce a somewhat changed field of radiation. Isodose curves have been calculated (see Fig. 11–13) using Sievert[40] integrals and assuming a line source without thickness dimension, a 0.3 mm. layer of steel with $\mu = 0.420$ cm.$^{-1}$, and at this

TABLE V

COMPARISON OF GAMMA ROENTGENS PER 100 MG. HR. OR ITS EQUIVALENT BETWEEN QUIMBY[32] AND PATERSON-PARKER[29] VALUES FOR LINEAR SOURCES AND PRESENT 0.3 MM. STEEL COBALT 60 NEEDLES (CONVERSION FACTOR USED: 1.607)

	Central axis (A line) 0.0			B line 0.5		C line 1.0		D line 1.5		E line 2.0	
	cm. from center along needle										
Cm. from needle	Paterson-Parker	Co^{60}	Quimby	Quimby	Co^{60}	Quimby	Co^{60}	Quimby	Co^{60}	Quimby	Co^{60}
	1 cm. active length										
0.5	2640	2600	2500	1760	1850	667	700	325	378		
0.75	1300	1300	1250	950	1010	527	570	297	311		
1.0	787	790	740	606	646	417	420	254	eq.		
1.5	361	352	352	323	336	256	eq.	186	eq.		
2.0	207	204	204	193	190	163	eq.	130	eq.		
2.5	133	132	132	125	130	113	eq.				
	2 cm. active length										
0.5	1820	1820	1800	1720	eq.	910	6.5% higher	385	464	195	273
0.75	1020	1025	1100	955	eq.	625	7% higher	333	365	189	220
1.0	654	630	625	570	eq.	435	eq.	270	290	168	185
1.5	332	320	333	303	eq.	257	eq.	189	eq.	135	134
2.0	195	180	196	185	eq.	159	eq.	131	eq.	102	(eq.)
2.5	128	126	125	121	eq.	111	(eq.)	96	(eq.)	80	(eq.)
	3 cm. active length										
0.5	1350	1370	1430	1333	1330	1111	1190	645	770	310	350
0.75	800	840	910	835	789	690	685	435	486	250	280
1.0	544	544	540	526	517	454	456	323	344	202	230
1.5	292	290	286	286	280	250	249	193	216	143	154
2.0	179	178	179	173	174	156	157	132	143	106	112
2.5	121	120	119	115	118	107	109	95	98	81	84
3.0	86	84	85	84		78		71		62	

time taking no account of the filtration in the cobalt wire itself. The unit used is the Imc. (Co^{60}) for a linear intensity of 1 mc. per cm. active length, the Imc. (Co^{60}) being the intensity of γ-radiation at a distance of 1 cm. from a 1 mc. point source of unfiltered Co^{60}—corresponding to the Sievert[39] unit. This can be converted into r_γ per 100 Σmc.hr. by a multiplication factor involving the specific dose rate k, the length l of the source in cm. and ρ, the linear intensity in mc. per cm. active length at any time. ρ will have to be recalculated from time to time because of the decay of Co^{60}

$$r_\gamma \text{ per } 100\ \Sigma\text{mc. hr.} = 100\ \text{Imc.} \times \frac{k \cdot \rho}{l} \qquad (7)$$

1 Imc. then corresponds to 1,350, 675, and 450 r_γ per 100 Σmc.hr. for a 1.0, 2.0, and 3.0 cm. source respectively, if $\rho = 1$.

The figures are in fair agreement with Quimby's[32] and Paterson-Parker[29] values for linear sources, although there are a number of odd differences (see Table v). These consist mainly in the rather higher values for the Co^{60} sources in the "near off-center" region (*i.e.*, on the C-, D-, and E-lines at 0.5 and 0.75 cm.). The probable explanation has been given above.

Hine and Friedman[13] have shown recently that isodose curves around radium needles calculated after Sievert[40] agree pretty well with absolute measurements for which they designed special ionization chambers. Our curves have not as yet been checked in this way.

IV. THE BUTTER EXPERIMENTS

Theoretical considerations regarding the biological action of γ-radiation in the Co^{60} energy levels do not predict any responses different from those obtained with radium γ-rays as long as all other factors can be equalized. These include as far as interstitial therapy goes nonabsorbability, *i.e.*, completely enclosed sources, linear intensity, dose rate and total γ-ray dose, similar geometry of application and dimensions of radioactive sources. The only difference then should be the γ-ray spectrum, and possibly a slight difference in secondary β-radiation. There are several ways of testing this hypothesis, namely a variety of animal experiments such as those presented by Meschan *et al.*[22] of the Arkansas Medical School. These authors injected a certain amount of caution into the discussion in view of their preliminary findings of an increased skin reaction with Co^{60} in two-thirds of the number of rabbits treated by implants and surface applications. There was still, however, a difference in the time element between Co^{60} and radium cases, mainly due to a difference in linear intensity.

The importance of biological experiments is shown also by Nickson *et al.*[27] in their findings of the absorption of cobalt when used unshielded.

We have confined ourselves so far to experiments with what one might call a semibiological medium, namely butter; Mr. J. E. Rose[36] having suggested to us this medium for a comparison between the γ-rays of radium and cobalt 60. The bleaching of butter under the influence of radium and radon was one of the early means of investigating the influence of filters and the dose distribution around radium sources. It was shown by Sugiura,[12] Failla,[11] Quimby,[31] and Quimby and Stewart[34] that the bleaching of butter was one of the properties of β- and γ-radiation, that the extent of bleaching depended on the strength of the source, the active length and the filtration, and could be correlated with the rabbit experiments of Cutler[7] who investigated the area of necrosis around bare and filtered radon seeds of various sizes and strengths, implanted in rabbit muscle. Quimby showed furthermore that the rate of growth of the bleached area was dependent only on the exposure, if a filtration correction was applied to the different sources.

The butter was prepared in a way similar to that described by Sugiura[12] but later it was found necessary to filter the melted butter several times in order to eliminate solid contents. The butter was then poured into petri dishes, allowed to cool and the radioactive sources inserted so that they came to lie flush with the surface. The bleaching that we could observe took a much longer time to establish than in the older experiments except for a preliminary set-up in which a 0.25 mm. monel bulb containing 25 mg. of radium was used. There was obvious bleaching present within less than twenty-four hours but when we went on to 0.5 mm. Pt needles of 1 mg. per cm. linear intensity and to our Co^{60} needles, the first signs of bleaching became apparent only after thirteen days and in another series not before the fortieth day. This delay may be due in part to the absence of backscattering material on the surface. Sugiura[12] showed that after placing suitable thicknesses of solid wax over the butter the rate of growth of the bleached area increased markedly, and Quimby's[34] experiments in 1931 used this method exclusively. We have not as yet carried out a similar series but want to investigate this point at a future date. The other large point of difference between the older series and our own experiments lies in the filtration. Except for a 50 mg. tube filtered by 0.5 Pt, all the sources used by the Memorial Hospital workers were filtered by 0.3 mm. Pt or Au or less, including a large series with bare radon seeds. The difference in γ-ray dosage is not as marked as the experimental divergencies and I believe that the contribution made by β-radiation is the deciding factor.

There is less than 0.1 per cent of the

primary β-radiation issuing from 0.5 mm. Pt filtration whereas 0.83 per cent of primary β-rays will penetrate 0.2 mm. Au constituting, according to Failla,[11] 22.5 per cent of the ionizing power of such a preparation. A glass seed 0.15 mm. thick produces radiation 96.5 per cent of whose ionization potential is due to β-rays. The most penetrating β-particles emitted by Ra C have an energy of 3.15 mev. with a maximum range in tissue—and equally in butter—of 1.5 cm. Compare this with the maximum energy of secondary β-particles produced in the steel wall of our Co^{60} needles corresponding to a maximum range in tissue of 4.1 mm. The nearest we could get to these conditions with radium was a 0.25 mm. monel bulb containing 25 mg. in 1 cm. active length.

The series of butter experiments were carried out with radium needles containing 1.0, 1.85, 2.2, and 3.1 mg. of radium all filtered by 0.5 mm. Pt, a 1.0 mg. needle with a filtration equivalent of 0.25 mm. Pt, as well as the 0.3 mm. steel needles containing 1 cm., 2 cm., and 3 cm. lengths of irradiated Co with activities of 1.2 to 3.6 mc. to start with. They have now lost about 20 per cent of their activity by decay.

The needles were placed singly into dishes and five petri dishes placed simultaneously for several months at a time into a refrigerator in such a pattern that the background radiation received by each dish of butter from the other four was equalized Best results were obtained with the temperature kept at 40° F.

Results. As already indicated we had to wait rather a long time before the bleaching became apparent. In the first series it was not until the thirteenth day for the strongest needle of this set, a 3.5 mc. Co^{60} source, and the nineteenth day for the other four needles that faint traces of bleaching could be recognized. The shapes of the bleached areas were by no means uniform at this stage and merit some consideration. The width of the bleached area when first observed varied from less than 2.0 to 2.5 mm.; this includes the thickness of the needle, *i.e.*, about 1.65 mm. The length of the bleached areas, however, followed a definite pattern: The Co^{60} needles showed bleaching along practically the whole of their active lengths from the beginning, the radium needles being cell filled, had bleached only for about one-half the length of the individual cell with definite gaps in the multicell needles. Only a special 1 mg. radium needle made up of a 0.375 mm. thick monel sheath containing a 0.2 mm. platinum cell had very extensive longitudinal bleaching from an early stage, extending well to the physical limits of the needle and even beyond the eye-end on the thirty-fifth day. In another series it was seen that the single-cell 10 mg. tube (1 mm. Pt filter) behaved like the cobalt needles with bleaching extending longitudinally well beyond the active ends from the earliest stages. The longitudinal extension of bleaching appears to be a function of the linear intensity as well as the filtration.

The actual diameters of bleaching from one set of experiments are shown in Figure 14 in relation to time. The data seem to fit a straight line relationship over a considerable range but the final "depression" is marked for all sources in this and some other sets. It is seen that, quantitatively, the cobalt sources fall naturally into line with the radium sources according to their strengths if one takes also into consideration the different dimensions and especially the active lengths. One can thus explain the greater diameter of bleaching for the 1 mc. Co^{60} needles as compared with the 2.2 and 3.1 radium needles, although the equivalent milligram hour value is smaller. By comparing the 1 mc. needle with a single cell rather than the whole of the radium needles the discrepancy disappears. I think this procedure is justified by the appearance and maintenance of dumb-bell patterns around the multicell radium needles.

The different stages reached by the area of discoloration of the butter around two of the sources—a 1 mc. Co^{60} and a 2.2 mg. Ra needle—are pictured in Figure 15 and the appearance after 184 days shown in a

photograph of the petri dishes with the needles in situ (Fig. 16 and 17). The contrast between the white of the discolored area—often shading a little into gray—is not brought out as distinctly in these photographs as it is seen in the actual plates. In the early stages, however, it is generally much less distinct and the limits of extension are at times difficult to distinguish for purposes of measurement. In contrast, Figure 18 shows the appearance of a similar experiment with the 0.25 mm. monel 25 mg. radium tube on the seventh day. (Tube 11 mm. long, 2 mm. diameter. Actual diameter of bleached area: 17 mm. —somewhat uneven on the two sides of the tube.)

The patterns around the multicell radium needles (1.85, 2.2, and 3.1 mg.) depend very much on the packing of the individual cells—a dumb-bell pattern can be recognized even after more than five months irradiation in some of them (see Fig. 17). The bleached area around the 10 mg. tube which has grown farthest in relation to the body of the tube actually showed the "dark" region of reduced radiation beyond the ends of the source by giving the well known double doughnut appearance. This was first noticed on the

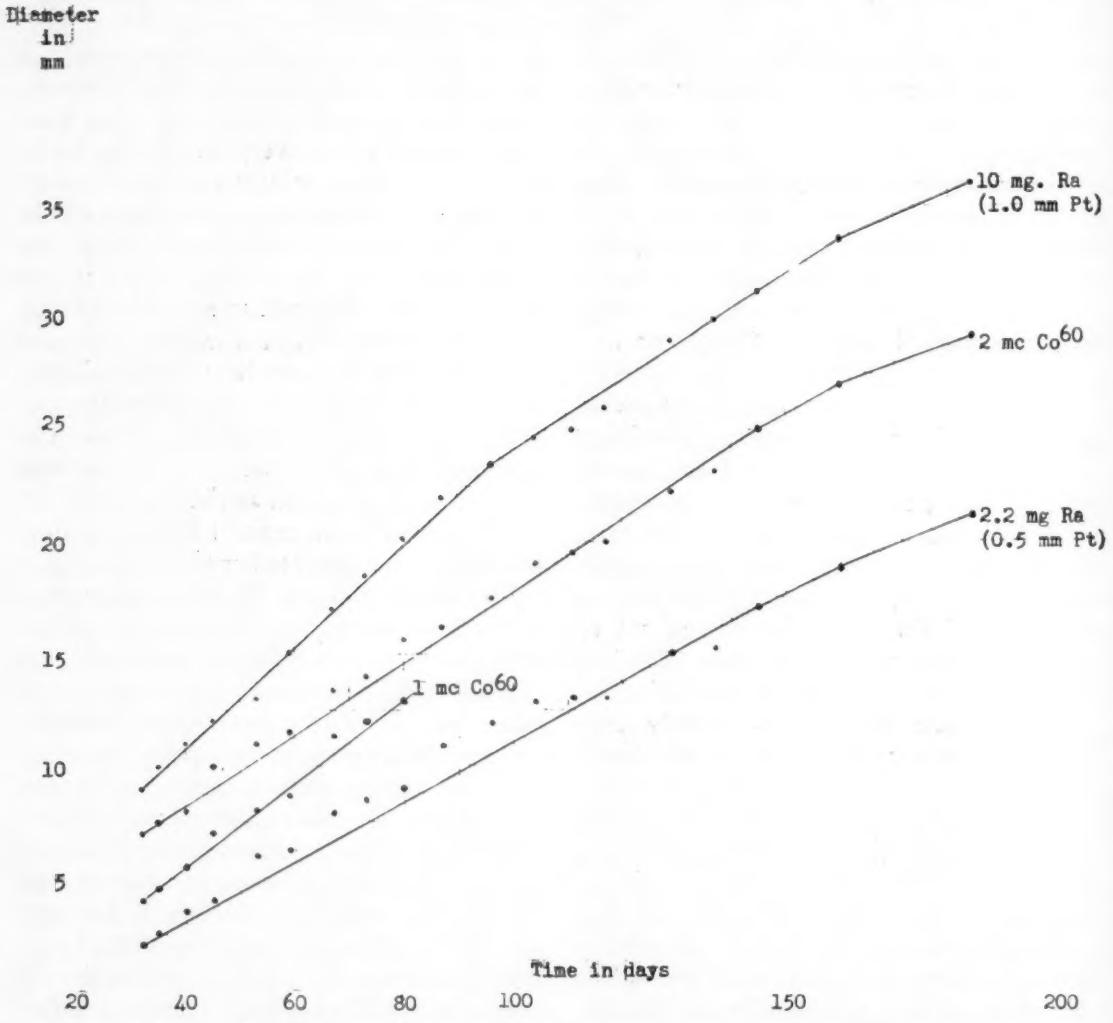


FIG. 14. Growth of bleached area with time for various Co^{60} and radium sources.

eighty-seventh day, and it is now, nearly 100 days later, quite well marked (see Fig. 19).

The absence of spontaneous extension of the area of discoloration, once the radioactive foci are removed, could be confirmed as long as proper refrigeration is kept up. As a by-product of these experiments it was established that, with the butter prepared in the way described earlier, neither the platinum radium sources nor the cobalt 60 stainless steel needles showed any sign of rust, having remained immersed for more than six months.

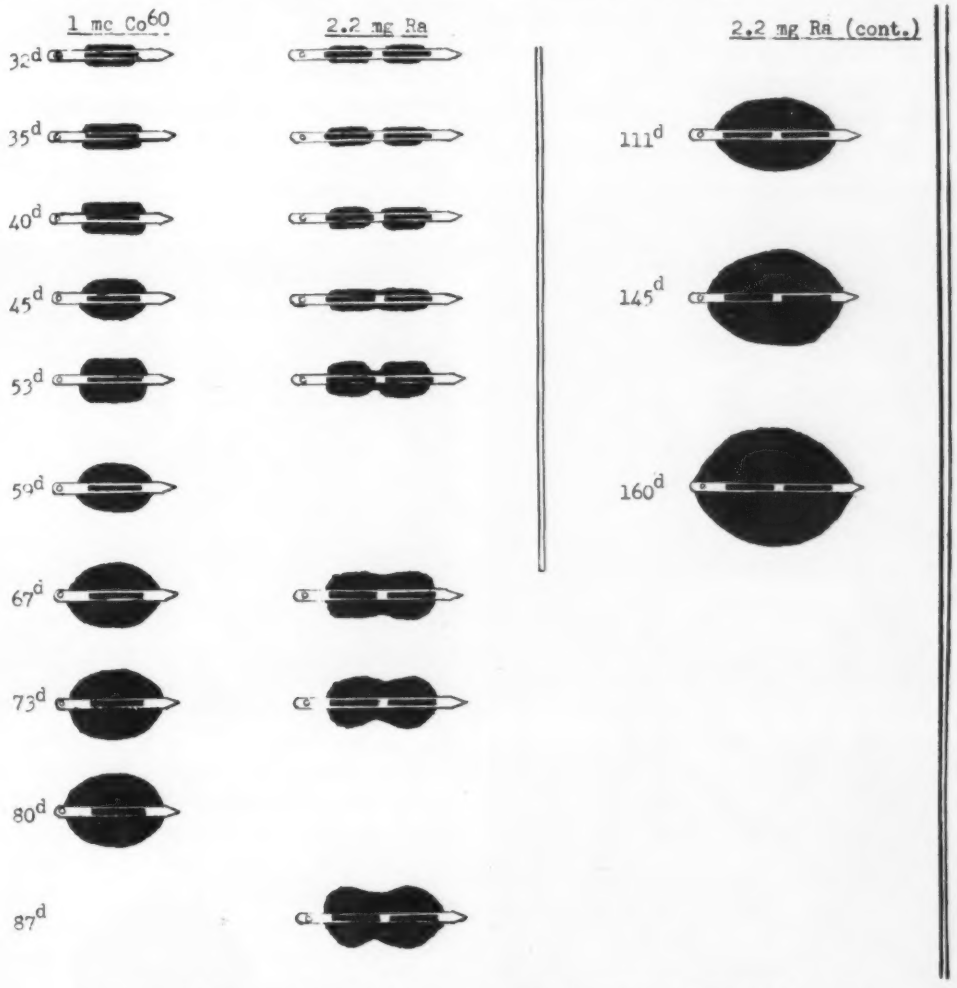


Fig. 15. Appearance of area of bleaching at various time intervals for a 1 mc. Co^{60} and a 2.2 mg. cell-filled radium needle.

Attempted Correlation with Gamma-Ray Dose. The actual patterns produced by the cobalt 60 needles markedly resemble the calculated isodose curves: the outlines of the bleached area around the 1 mc. needle on the thirty-second and forty-fifth day are almost exact replicas of the 10.0 and 5.0 Imc. lines respectively (compare Fig. 15 and 11). But there is in our experiments apparently no simple relationship between the γ-ray intensity or dose at any point and the time at which the bleaching extends as far. In fact, the dose in r_γ corresponding to the appearance of bleaching at a particular point falls gradually with distance from the source (see Table VI). This may be the same effect as that described by Quimby[34] as a greater sensitivity of the

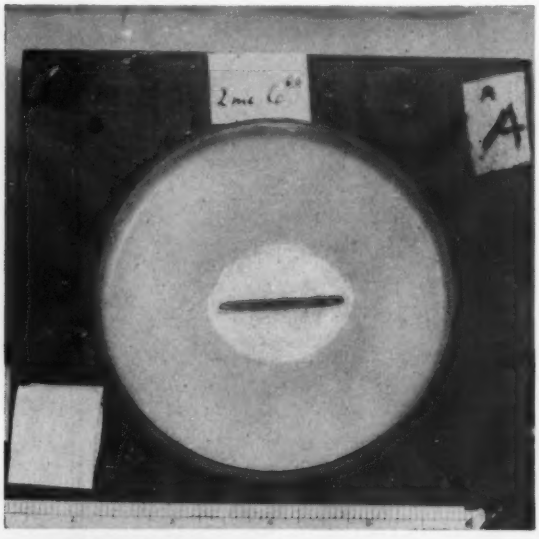
Table VI
(See text)

Radius cm.	r_γ
0.35	80,000–87,500
0.50	62,920–66,500
1.0	53,400–58,800
1.35	40,800–46,650

butter to bleaching with time, and especially noted as a "burst of activity" towards the end of the active life of a radon source. The time factor with which we have been dealing is of course still very much larger, running into as many months as the early experimenters dealt in weeks.

There is a certain amount of uniformity between the three cobalt 60 sources as regards the gamma roentgens delivered for various maximum diameters or "radii" of bleaching (1.2, 2.0, and 3.6 mc.). The figures are shown in Table VI. Similar figures calculated for our radium sources show much greater variations.

On the other hand, when Quimby's[34] experiments are analyzed in this fashion they are found to be of a rather different pattern. Five and 10 mg. of Ra, 0.25 mm.



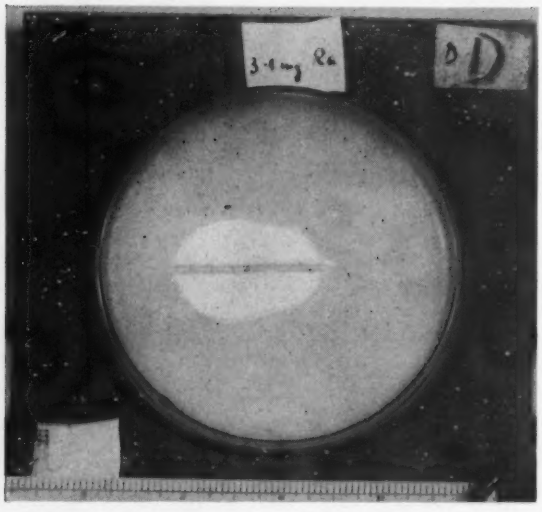


Fig. 16 and 17. Appearance of bleaching around 2 mc. Co^{60} and 3.1 mg. radium needles on 188th day.

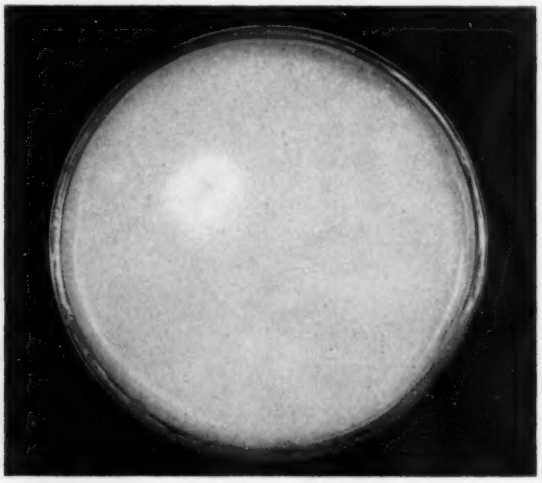


Fig. 18. Appearance of bleaching after 6½ days' irradiation with embedded 25 mg. radium bulb of 0.25 mm. monel wall thickness.

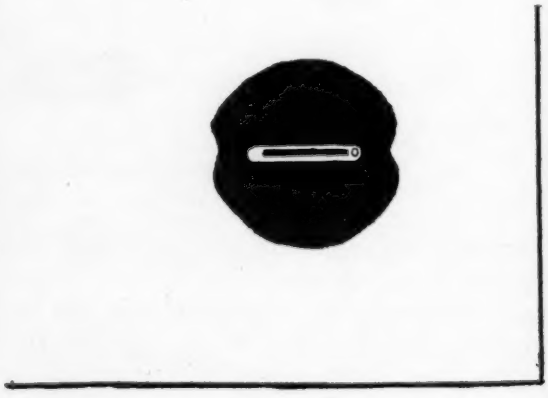


Fig. 19. Appearance of bleaching around 10 mg. radium tube (1.0 mm. Pt. filter, single cell) on 188th day.

Pt filter, and 0.3 mm. Au Rn-seeds of 7.9 and 10.75 mc. "required" from 30,000–37,600 r for 0.5 cm. bleaching, whereas 0.75 cm. bleaching was attained with 30,000 (5 mg. Ra) and 39,600 r (10 mg. Ra) respectively. A 20 mm. active 50 mg. Ra) source (0.5 mm. Pt) produced its bleaching at the margins of areas with diameters of smooth curve (see Fig. 20) indicating that the rate of growth of the bleached area is practically the same for all the sources used. Our data are too meager as yet to attempt the evaluation of a comparative dosage scheme—taking truly biological effects into consideration—such as described by Failla and Quimby,[11,12,31,34] but the evidence is

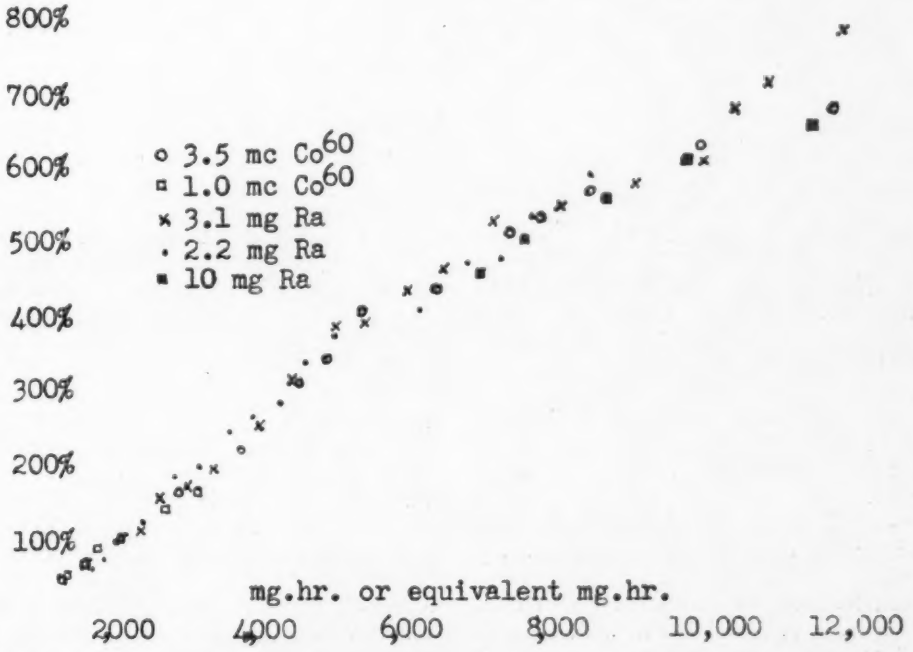


Fig. 20. Relative growth of bleached area with milligram hour or equivalent milligram hour dose. (Area reached with dose of 2,000 mg.hr. or equiv. called 100 per cent). (After Quimby and Stewart.[34])

between 1.0 and 4.0 cm. with a mean dose of 22,030 $r_\gamma \pm 11$ per cent, in marked contrast to our own figures, and even at 7 cm. the "wave front" was still at over 15,000 r_γ (compare Table VI for our results).

An analysis of all the data in a manner similar to that described by Quimby,[31,34] namely, to relate one dimension of the bleached area (diameter or radius) to the same dimension obtained by a certain mg. hr. exposure (irrespective of the strength of the source) is shown in Figure 20. The diameter of bleaching obtained with an exposure of 2,000 mg. hr. or its equivalent is called 100 per cent and where this could not be observed, a different part of the resulting curve was used as reference point. Nearly all values fall on a more or less sufficient to show the essential similarity of action of radium and cobalt 60 in regard to this effect of butter discoloration.

SUMMARY

1. The physics of Co^{60} is reviewed and the requirements for sheathing interstitial Co^{60} sources discussed.

2. A calculation is made of the secondary radiation induced in such sheaths and electroplated layers in terms of photoelectrons and first order recoil electrons. It is pointed out that this secondary beta radiation corresponds to an equivalent of 35 "μc." per mc. of Co^{60} of which more than 50 per cent is highly energetic (0.6 to 1.25 mev.).

3. A program of acquiring a series of

sources with at least two linear intensities different by a factor of 2:1 is outlined.

4. The problems of dose determination, absorption and protection are discussed.

5. The dose distribution around 0.3 mm. steel sheathed Co^{60} is presented in the form of iso-intensity curves.

6. Butter bleaching experiments are described which show that, for this effect at least, there exists essential similarity of action between linear sources of radium and Co^{60}.

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EXPERIENCE WITH A SIMPLE RADIUM APPLICATOR FOR HIGHER PARAMETRIAL DOSAGE IN CANCER OF THE CERVIX UTERI

By V. KAHANPÄÄ, M.D.
HELSINKI, FINLAND

THE most important advantage of radium treatment for cancer of the cervix uteri is probably that cures can be obtained in some of the cases in which operative means no longer help because of parametrial extensions of the cancer. However, the farther from the cervix or the vaginal wall the cancer has grown or infiltrated the lymph nodes, the worse the prognosis. Treatment of the parametria, and especially of the lateral parametrial fields, has thus become an important problem also from the point of view of radiation therapy in cancer of the cervix.

In a previous work I have described different methods developed for intensified irradiation of the parametrial fields and a simple vaginal radium applicator devised by me in 1944 for the same purpose. It seems advisable to summarize here briefly the construction and use of this applicator.*

As shown in Figure 1, the shape of the applicator is that of a narrow U. It is made of stainless steel plate and there are radium cylinders at the ends of both arms, which are bent outwards. After inserting the radium tube by the usual method into the uterus, the closed applicator is introduced into the vagina. The radium cylinders in the vaginal fornices then, thanks to the spring tension of the arms, push markedly in the lateral direction helped by a tight gauze pack between the cylinders. In the area behind the cylinders there is also a gauze pack for protection of the rectum. Finally, the applicator is once more pushed inwards by pressing its protruding handle with the flat of the hand, and it is fixed in this position by a tight Y bandage. By this last measure it is possible to press the cylinders 1.5 to 2 cm. farther in. *Thus, by the aid of laterally and upward directed components of force, the cylinders are brought in each case as close to the parametria as possible under the anatomical conditions* (Fig. 2).

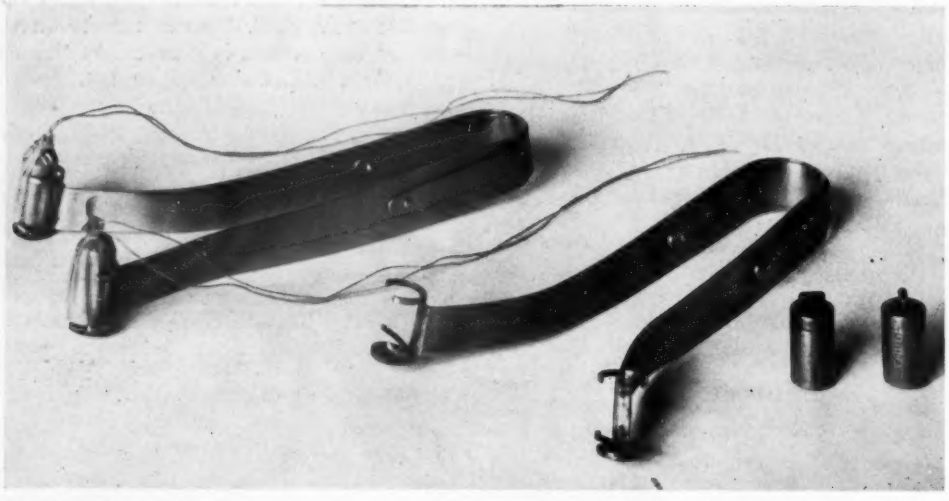

FIG. 1. On right the applicator and cylinders are shown separately; on the left, the cylinders with their thin protective rubber shields ready for use in the arms of the applicator.

In our Institute the modified Stockholm

* For a detailed description see *Acta radiol.*, 1946, *27*, 495–504.

method is used. Each patient with carcinoma of the cervix usually receives three radium treatments at weekly intervals. At the second treatment—the middle one—the applicator is used. Hitherto it has thus been applied only once in the case of each patient. However, a considerably higher radium intensity application has become possible with its aid: each cylinder contains 60 mg. radium element, and, by bringing these radiation sources as lateral as possible, the degree of effectiveness of the irradiation towards the parametrial pelvic fields has increased.

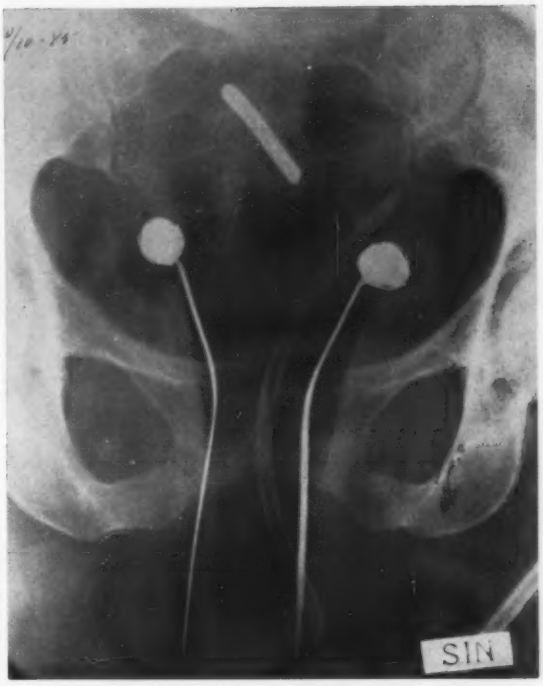

Fig. 2. Roentgenogram of the applicator in situ, front view.

PHYSICAL FACTORS

In the treatment of cancer of the cervix a radium tube is always employed for uterine application. Plates or cylinders of different size have been used for vaginal application. We have radium sulfate in needles. The tubes, plates and cylinders are similar to those in Radiumhemmet, Stockholm, described repeatedly by Heyman in his articles. Filtration corresponds to 3 mm. lead.

The radium dosage has varied much from the beginning according to the individual case, but generally it has been slightly higher than that of the Stockholm method.* To obtain a good basis in physics, in addition to our clinical experience, our physicist, Professor P. E. Tahvonen, as early as 1939, calculated and drew the isodoses of our different radium sources (*Chydenius*). These curves are based on accurate mathematical calculations and numerous measurements made with the aid of ionization chambers constructed according to Zimmer's principles; these measurements were in addition checked by the film method. Tissue absorption has not been taken into account; the measurement and calculations are based on radiation in air. It is well known that gamma radiation, as measured in water, gives about the same results as in air and that secondary radiation within the tissues, with the exception of the skeleton, compensates for the error which results when the absorption of the primary radiation in the tissues is disregarded. Under these circumstances we can use our isodoses without any appreciable error arising for determining the radiation (in roentgens per hour) falling on a particular pelvic field from radium sources applied to the uterus and to the vagina.

Professor Tahvonen has kindly drawn also the isodoses around my applicator, taking into account, in addition to the cylinders containing 60 mg. radium element, one tube containing 60 mg. radium element, which we in most cases use for intrauterine treatment. Although the tube is by no means a part of the applicator but is separately introduced into the uterus before vaginal application, intrauterine and vaginal treatment are invariably given simultaneously, and therefore the tube must be taken into account in drawing the isodoses.

The isodoses around the applicator and the intrauterine tube are drawn in three

* This also applies to roentgen after-treatment; in most cases 3,000 roentgens has been applied to each parametrium (calculated depth dose).

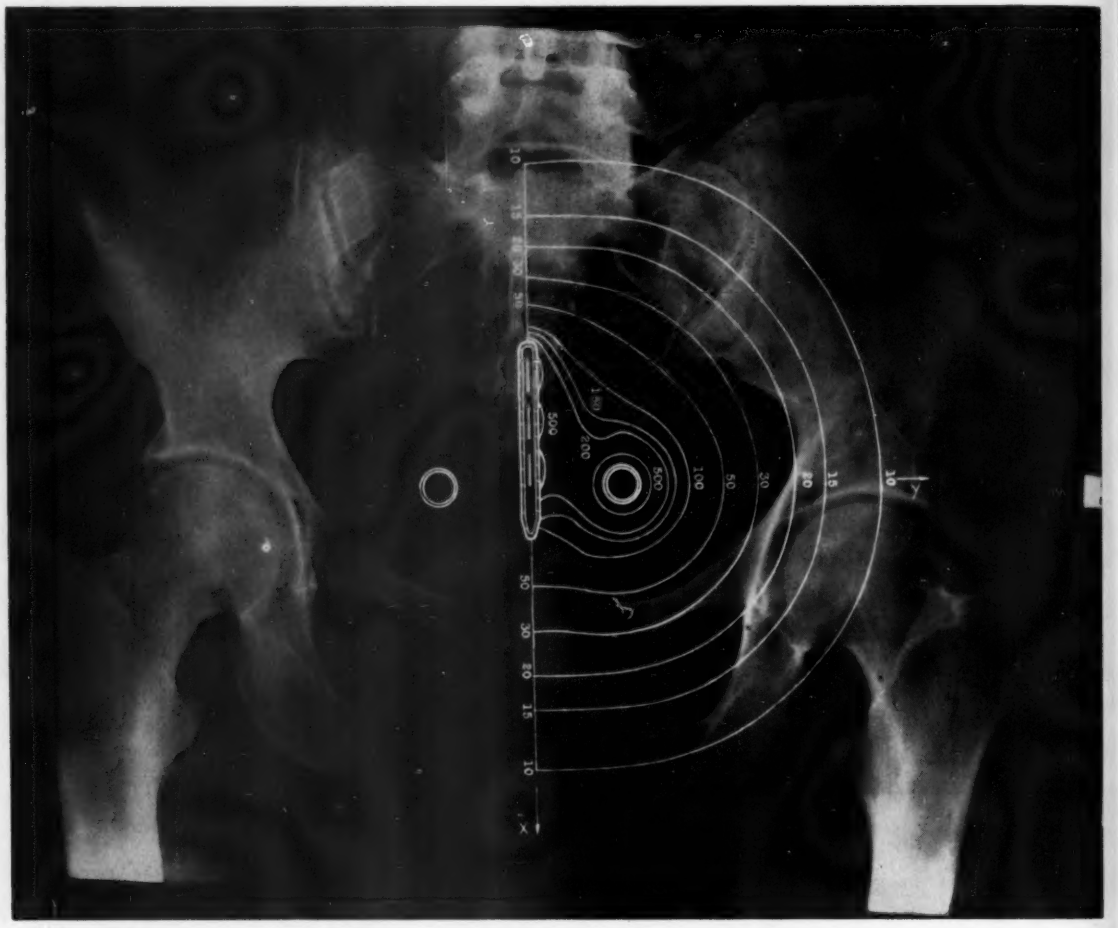

FIG. 3. Isodoses in roentgens per hour around the cylinders and the intrauterine tube. Patient in horizontal position, horizontal or *XY* plane (scale 1:2).

planes: in the horizontal or *XY* plane (Fig. 3), in the vertical-transervse or *YZ* plane (Fig. 4), and in the vertical-sagittal or *XZ* plane (Fig. 5).

In order to compare the radiation doses to the lateral parametrial fields obtained by the applicator and by the old method, *i.e.*, two radium cylinders each containing 60 mg. radium element side by side with a glass "sled," 0.5 cm. thick in the middle, between them, the radiation falling on three observation points during equal time of application by the two methods has been measured. These points are situated in the most important plane, the horizontal, at a height which is equally favorable for both methods. The first two observation points are on the horizontal line passing through the middle of the cylinders, *viz.*, the first at a distance of 5 cm. from the midline by both methods (*A* and *A'*) and the second 6.5 cm. from the midline (*B* and *B'*). The third observation point (*C* and *C'*) is, like the first, 5 cm. from the midline, but 3 cm. higher or more in the oral direction. These

TABLE I

	A–A'	*B–B'*	*C–C'*
Irradiation (roentgens per hour)	118.6–44.0	44.6–26.1	50.3–38.9
Relation of dosages	2.70	1.71	1.29
Gain by applicator	170%	71%	29%

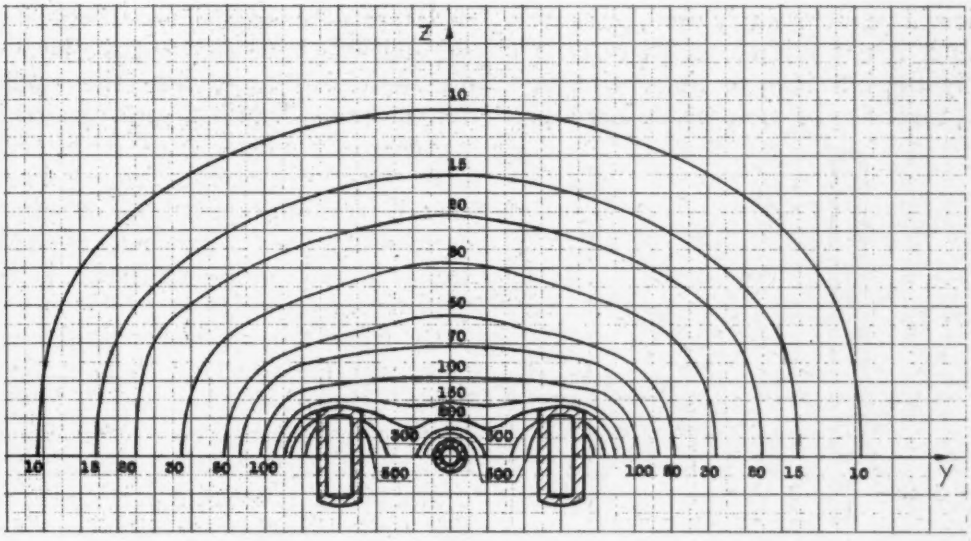

Fig. 4. Isodoses in vertical-transverse or *YZ* plane (scale 1:2).

points are thus all laterally situated, point *B* (*B'*) in the normal pelvis quite close to the lateral pelvic wall (Fig. 6 and 7).

Table 1 shows the radiation doses noted at these different points, the relation of doses at two corresponding points, and the gain in irradiation by the use of the applicator.

The amount of radium and the time of application being equal, it is thus possible to obtain considerably increased radiation dosage towards the parametrial fields with the applicator. Directly lateral to the cylinders of the applicator, 5 cm. from the midline, the improvement is 170 per cent, and 6.5 cm. from the midline, i.e., close to the lateral pelvic wall, it is still as much as 71 per cent. Higher in the pelvis where the intrauterine tube by both methods plays a relatively greater part in the irradiation, the difference is no longer so great (still, at *C* and *C'*, it is 29 per cent in favor of the applicator).

CLINICAL OBSERVATIONS

Since the beginning of 1945 a complete course of radium treatment has been given in our Institute to 574 patients with carcinoma of the cervix uteri. My applicator was used in 342, or 60 per cent, of these cases. Our experience has been so favorable

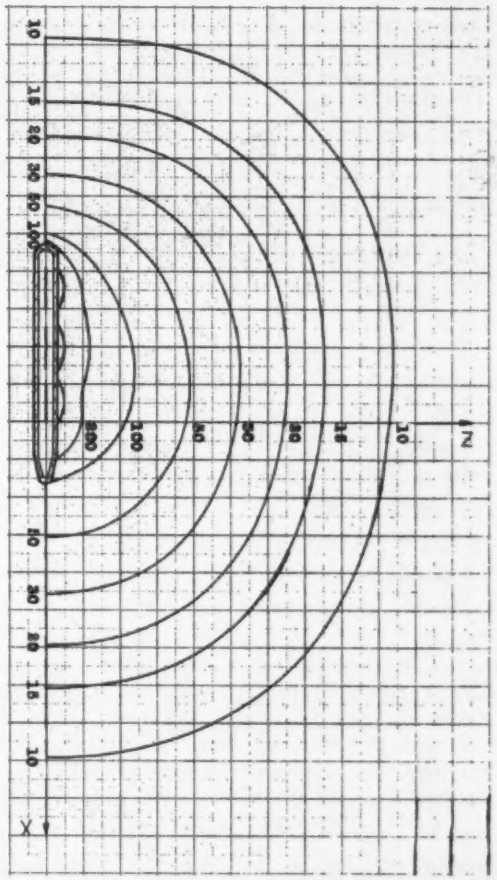

Fig. 5. Isodoses in vertical-sagittal or *XZ* plane; only the intrauterine tube lies in this plane (scale 1:2).

that it will be increasingly used, but nevertheless it is not suitable in all cases. Especially the introitus, or the vagina as a whole, must not be too narrow. Yet a previous pregnancy is not a necessary requirement; the applicator has been used in 21 of 48 nulligravidae. But if the vagina has undergone marked senile atrophy or if widespread cancer infiltrations in the vaginal wall have changed the latter into an unyielding tube, then the applicator cannot be used. It has been applied in 89 per cent of the cases in cancer of Stage I,* in 63 per cent of cases of Stage II, in 45 per cent of cases of Stage III, but in only a few cases of Stage IV (22 per cent). In these latter, as is well known, treatment is mostly palliative.

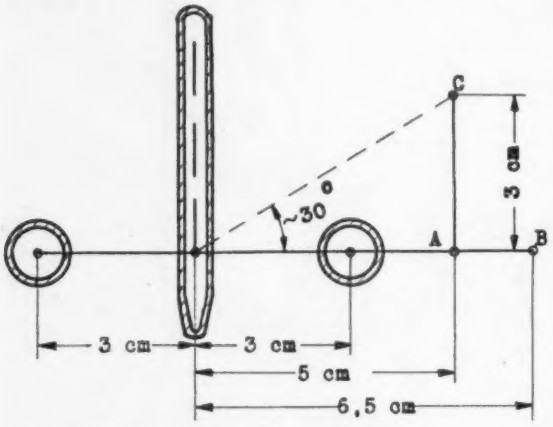

Fig. 6. Position of radiation sources in the uterus and in the lateral fornices of a vagina of normal width. Position of points *A*, *B* and *C* where the irradiation in roentgens per hour has been calculated and the results compared with the old method (Fig. 7).

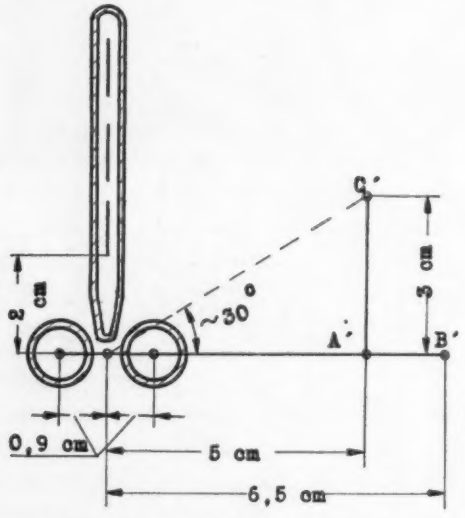

Fig. 7. The old method of application in which cylinders introduced into the vagina were separated from each other only by a glass "sled" 0.5 cm. in thickness. In points *A'*, *B'* and *C'* the irradiation has been calculated for comparison with the new method.

By using the applicator at the second treatment the rectum wall is strained at points other than when radium is applied by the usual method with plates, when the radiation to the rectum is concentrated in the middle of its anterior wall. As the radiation strain is in this way distributed over a wider area of the sensitive rectum wall, it has been possible to increase the whole radium dosage appreciably, as is evident from Table II.

Table II

In our Institute 1945–1949	Vagina	Uterus	Total
	mg. hr.	mg. hr.	mg. hr.
Technique with applicator	5,890	3,280	9,170
Technique without applicator	4,619	2,961	7,580
Differences between dosages	1,271	319	1,590

However, the cases in which the applicator was used include a greater proportion of favorable (Stages I and II) cases than those treated without the applicator, among which latter are most of the old patients. Therefore I have compared the dosages also in a different way: the whole case material treated in 1945 to 1949, when the applicator was in use (in 60 per cent of the cases), has been compared with that treated in 1937 to 1942 when the applicator was not yet used but the treatment method was in other respects similar (Kahanpää and Kankkunen). This comparison is shown in Table III.

* International classification.

In the cases in which the applicator was employed, the vaginal radium dosage has thus been increased considerably. The patients have been given 1,271 mg. hr., or 27.5 per cent, more radium on an average than those treated without the applicator. Even if the applicator was used in only 60 per cent of the patients treated for carcinoma of the cervix in recent years, the effect of the use of the applicator appears also from the dosages in the total material: the vaginal dosage increased by 666 mg. hr., or 14.1 per cent, from the level of the preceding years.

Table III

Dosages in our Institute	Vagina	Uterus	Total
	mg. hr.	mg. hr.	mg. hr.
1945–1949	5,376	3,150	8,526
1937–1942	4,710	3,300	8,010
Differences between dosages	666	−150	516

As will be remembered, Heyman's schema (original Stockholm method) was: vagina 4,000 to 4,500+uterus 2,400= 6,400 to 6,900 mg. hr.

Only a few patients treated with the applicator have been followed for over five years and it is therefore too early to say how the final incidence of recovery will be affected by the introduction of the new instrument, by the resulting increase in absolute radium dosage, and especially by the improved lateral irradiation effect on the parametrial areas. This can only be demonstrated by further statistical studies on the subject.

Yet experience to date suffices to show whether the use of the applicator here described and the higher vaginal dosage has proved safe or whether complications have increased. Rectal injuries are most illustrative in this respect (Table IV).

Table IV

Technique	Rectal Bleeding	Rectal Stricture	Recto-vaginal Fistula
Without applicator (232 cases)	30=12.9%	8=3.4%[1]	2=0.9%
With applicator (342 cases)	19= 5.6%	2=0.6%[1]	0

[1] In only one case was the stricture so severe that an artificial anus had to be formed.

Although the incidence of rectal complications increases somewhat when all cases are followed sufficiently long—which must be kept in mind when comparing these figures with the incidence of complications reported, for example, by Ingelman-Sundberg from Radiumhemmet in Stockholm—Table IV shows a distinct difference between the number of rectal injuries in the cases treated with and without the applicator. The small number of strictures in the former is of special interest, and so is the fact that hitherto no single fistula has appeared in these cases. *The applicator with its considerably higher vaginal radium dosage has brought about no increase in the incidence of rectal complications; on the contrary, these have definitely diminished in number.*

Concerning other applicators

When I first described my new instrument in 1946 I compared it with earlier techniques, especially with the vaginal treatment of the Stockholm method and with Regaud's colpostat. Technically it is more closely related to the French school, yet it differs considerably even from the colpostat. My applicator allows the radium cylinders to be placed individually according to the anatomical requirements in each case, and the cylinders automatically assume a maximally lateral position. *As the handle of the appliance protrudes from the vagina, pressure from the outside may be applied to prevent the cylinders from shifting downward in the vagina.*

Richards' applicator is not suitable if the introitus is not rather wide.

The instruments devised by Ernst and by Campbell are more recent than my applicator. These, like American applicators in general, in my opinion have the disadvantage that the intrauterine tube is

directly connected with the applicator. Although this is practicable under fairly normal anatomical conditions, the case is different *when the cancer has greatly altered the topographical conditions. In that case it is a very valuable advantage that intrauterine application can be separately provided first and my instrument then used for vaginal application, quite independently of the position of the intrauterine radium tube. As even a large tumor of the portio uteri can be accommodated between the arms of my applicator, the radium cylinders can enter deep into the lateral fornices also in these cases in which the T applicator with its cylinders will necessarily remain in a more distal position in the vagina.*

SUMMARY

With the applicator the radium dosage for the treatment of carcinoma of the cervix uteri (342 cases) has averaged: uterus 3,280 mg. hr.+vagina 5,890 mg. hr.=9,170 mg. hr. As far as vaginal treatment is concerned, this signifies an increase of 14.1 or 27.5 per cent in absolute radium dosage, according to different criteria. However, the more lateral placement of the cylinders increases greatly the effectiveness of irradiation towards the parametrial areas. Dosage and time of application being equal, the increase in radiation dosage (in roentgens) at a distance of 5 cm. from the midline is 170 per cent and at a distance of 6.5 cm., 71 per cent. Fewer rectal injuries followed in the cases in which the new method was used than in those treated without the applicator.

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Vol. 69, No. 3

A SIMPLIFIED TECHNIQUE FOR ROENTGENOGRAPHY OF IMMOBILIZED PATIENTS

By R. S. CLAYTON, M.D., *and* M. F. LLEWELLYN, R.T.
DALLAS, TEXAS

WE HAVE found the following roentgenographic technique extremely useful in the examination of hospitalized patients who are surrounded by equipment or apparatus which prevents placing the portable roentgen machine tubehead in its usual location above the patient.

Orthopedic patients who are in traction apparatus which is suspended from overhead structures often require daily roentgenography to determine the effects of traction and other maneuvers on bone fragments, or to follow the progress of healing. Moving the orthopedic apparatus to allow proper placement of the tubehead may be impractical or impossible. Placing the cassette beneath the extremity may be difficult because of sandbags, pillows, etc. Also, even minimal movement of a fractured extremity may be quite painful.

Many roentgenologists assume that the metal structures of a hospital bed would interfere with the diagnostic value of roentgenograms made by directing the roentgen-ray beam upward through the bed. Where indicated, we roentgenograph these patients by placing the tube beneath the bed and laying the cassette on the part to be studied. A typical arrangement is shown in Figure 1. A roentgenogram obtained by the use of this technique is shown in Figure 2. Only rarely are the metal structures superimposed so as to interfere with the diagnostic value of the roentgenogram. In such cases, random repositioning usually provides an adequate study. The 90° study is easily accomplished and requires no mention here.

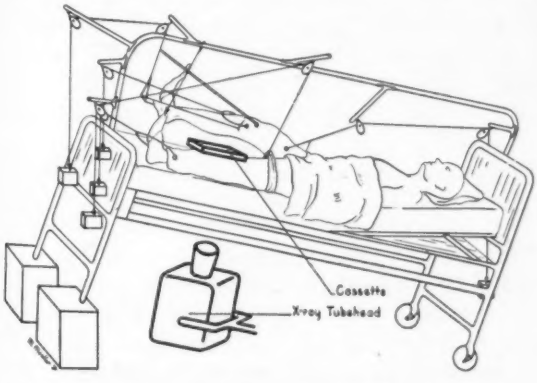

FIG. 1. Diagram of arrangement for through-the-bed roentgenography.

FIG. 2. Roentgenogram of knee made through hospital bed.

The metal shadows can be eliminated by replacing the steel netting of the bed with radiolucent webbing. In roentgenography of smaller extremities which are held in mid-air by traction, bringing the roentgen-ray tube closely against the undersurface of the bed will help to minimize interference by the metal shadows.

To compensate for the interposed structures, we have found it necessary to add only slightly to the average technique factors. The usual hospital mattress, pillows,

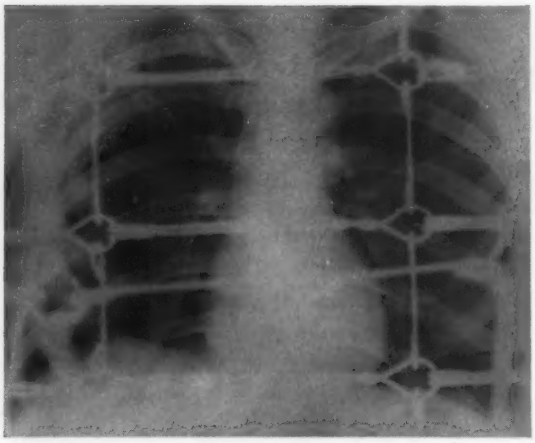

FIG. 3. Roentgenogram of chest made through hospital bed.

etc., require addition of 6 to 8 kv. (peak). The target-film distance varies depending on the following factors: (1) the height of the part above the bed, (2) the height of the bed above the floor, and (3) the lowest position of the tube permitted by the particular machine used. Cones and grid cassettes are used to obtain maximum film contrast.

We have used this technique in portable roentgenography of the chest. In this situation, elevation of the head of the bed will increase target-film distance. The tubehead is angled so the central ray is still normal to the center of the cassette. Instead of the usual anteroposterior projection at 30–35 inches target-film distance, a posteroanterior projection at 40–50 inches is obtained, an obvious advantage. There is no lifting of the patient in placing and removing the cassette, and associated devices such as oxygen tents, chest suction tubing, bandages, intravenous medication connections, etc., are not disturbed. A roentgenogram of the chest made in this manner is shown in Figure 3. Use of radiolucent webbing to support the mattress would be highly desirable in through-the-bed roentgenography of the chest, as the shadows of the metal lattice are more distracting than in the study of extremities.

For roentgenography of large parts such as the chest or pelvis the entire bed may be elevated by placing it on suitable supports.

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Representatives on American Board of Radiology: B. R. Kirklin, Rochester, Minn., H. Dabney Kerr, Iowa City, Iowa, U. V. Portmann, Tucson, Ariz.

Representative on National Research Council: A. O. Hampton, Washington, D. C.

Editor: Lawrence Reynolds, 110 Professional Building, Detroit 1, Mich.

Assistant Editor: Ruth Bigelow, 110 Professional Building, Detroit 1, Mich.

Fifty-fourth Annual Meeting: Netherland Plaza Hotel, Cincinnati, Ohio, September 29–October 2, 1953.

AMERICAN RADIUM SOCIETY

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Representatives on American Board of Radiology: Douglas Quick, New York, N. Y., B. P. Widmann, Philadelphia, Pa., Frederick W. O'Brien, Boston, Mass.

Committee on Arrangements: Wendell G. Scott, Chairman, St. Louis, Mo., Axel N. Arneson, St. Louis, Mo., Edwin C. Ernst, St. Louis, Mo., LeRoy Sante, St. Louis, Mo.

Representatives on National Committee for Radiation Protection: Edith H. Quimby, New York, N. Y., John E. Wirth, Pasadena, Calif.

Thirty-fifth Annual Meeting: Chase Hotel, St. Louis, Mo., April 20, 21 and 22, 1953.

EDITORIALS

Dr. Arthur C. Christie (left) being congratulated by Major General George C. Armstrong, Surgeon General of the Army, on the occasion of the dinner honoring Dr. Christie.

ARTHUR C. CHRISTIE, DISTINGUISHED PHYSICIAN AND RADIOLOGIST

ON SATURDAY evening, December 20, 1952, a host of friends of Dr. Arthur C. Christie, of Washington D. C., one of the world's great radiologists, honored him with a dinner at the Shoreham Hotel in recognition of his near half century of service to the medical profession. This memorable occasion was not only a tribute to Dr. Christie for his long service in the practice of medicine and radiology and for his important contributions to his own profession, but it was also an expression of the high regard with which he is held in the city of Washington and elsewhere by nonprofessional people as well. Indeed, during the forty-seven years of Dr. Christie's active practice in the field of medicine perhaps no one has contributed

more toward the furtherance of the ideal which he cherished for the position of radiology in the medical world and he, along with the other pioneers in the radiological profession, has worked unstintedly toward the accomplishment of this end. Dr. Christie has seen and has helped radiology grow from a rather anemic plant in the basement or some other neglected area of the hospital to the high position which it holds in the field of medicine today.

No one had a better background for the beginning of his profession than did Dr. Christie. He was born in West Sunbury, Pennsylvania, in 1879, the son of a country doctor, and he has exemplified the general belief that the sons of clergymen and doctors have a better chance of success in life than almost any other group of men. In his early years he began to appreciate the values in life, not the monetary values but the intrinsic values of the worthwhileness of things and people. Following his medical education at the Cleveland College of Physicians and Surgeons, he himself practiced general medicine in Clymer, New York, serving a large rural community, which further fortified him for the splendid position which he was subsequently to hold in the medical world. It was in 1906 that he joined the Medical Corps of the United States Army, and almost immediately he became interested in radiology, a science which was then in its infancy. Indeed, Dr. Christie says that he "became a radiologist 'by order of the Surgeon General of the Army'," and it may be noted that perhaps the Surgeon General never issued an order which was more fruitful in its results.

Soon Dr. Christie became a leader in his profession. In World War I he was Chief of the Division of Roentgenology of the Army Medical Corps and he has been a distinguished leader in the special fields of roentgenology and radiology ever since. His notable contributions during World War I played a great part in reducing the effects of the injuries that occurred during that tragic era. This was accomplished by his great ability in leadership and organization and his insistence upon the best type of service that could possibly be given for the care of the sick and wounded.

At the end of the War, Colonel Christie, as he was known at that time, resigned from active service in the Army and began the practice of radiology in the District of Columbia with the late Dr. Thomas A. Groover. The Radiological Clinic of Drs. Groover, Christie and Merritt, which Dr. Christie has long directed, has become known throughout the world as standing for the best in the practice of medicine and radiology.

Throughout the years Dr. Christie has occupied a prominent place in the medical profession and has shown a keen interest in the civic affairs of the District of Columbia. He has concerned himself with advancements not only in the field of radiology but in all phases of medical practice as well, and in the better care of the old and the indigent.

Dr. Christie's ability and the prodigious application of his active mind have enabled him to accomplish many things of great importance in the years that he has been in medical practice. He was a leading member of the Committee on the Cost of Medical Care, which was appointed during President Hoover's administration, and of which the two reports, majority and minority, are among the most famous documents in medical economics. He served as President of the Board of Trustees of American University, as President of the Rotary Club, and he has been an outstanding and active member of the Methodist Church. He was onetime President of the American Roentgen Ray Society, and the Editor of its official JOURNAL from 1924 through 1929, during which time radiology was experiencing its most fruitful advancement, and his considered judgment and brilliant mind contributed enormously to the prestige and position which the AMERICAN JOURNAL OF ROENTGENOLOGY, RADIUM THERAPY and NUCLEAR MEDICINE enjoys today. In 1937, Dr. Christie was elected President of the Fifth International Con-

gress of Radiology in recognition of his world wide reputation in the radiological field.

These are but a few of the many eminent positions which Dr. Christie has held throughout his active life. During his forty-seven years in the practice of medicine, he has constantly contributed to the medical literature articles on the use of roentgen rays in diagnosis and treatment, as well as numerous papers dealing with medical economics, and other phases of medicine.

Dr. Christie has always "preached the dignity of labour, the necessity of righteousness, the love of veracity, the hatred of shams." He has been a friend of the younger men in the practice of medicine and his precept and example have not only been a stimulus to them but a challenge to the oldsters. There is an old Chinese proverb which says, "He who looks back to the old and knows the new is worthy to be a scholar," and certainly Dr. Christie is the exemplification of this. He has known radiology from its beginnings and he has not only followed but has contributed to its advancement throughout these many years. On the evening of the great dinner honoring him, he said, "In my whole career I have been under the control of the disciplines of science; now I have time for other things. I will not be practicing medicine, I am quite interested in raising azaleas, and of course there will be some fishing and reading and writing." If Dr. Christie in his retirement cultivates azaleas with the same assiduousness and care that he has devoted to the practice of medicine his blossoms should reach well nigh a state of perfection, and in the serenity of his garden under the tropical sun of Florida he may look back with satisfaction on a full life. His splendid accomplishments in the practice of medicine and radiology place him among the greats in these fields and he carries with him in his retirement the plaudits of a multitude of friends in both the lay world and the medical profession.

BIOGRAPHIC MATERIAL

Arthur Carlisle Christie, M.D., D.Sc. (Hon.)
Born: West Sunbury, Pennsylvania, December 29, 1879
Father: Milton H. Christie, M.D.
Mother: Harriet Josephine Rhodes Christie
Married: Maude Irene Hopkins, June 1, 1904
Children: Mrs. Geneva I. Morris
Milton A. Christie
Carlisle V. Christie
Harriette I. Beck
Corry, Pennsylvania High School; graduated 1898
Cleveland College of Physicians and Surgeons (Medical Department, Ohio Wesleyan University), Cleveland, Ohio, 1904
Army Medical School, Washington, D. C., graduated 1907
Fellow, American College of Radiology (F.A.C.R.)
Fellow, American College of Physicians (F.A.C.P.)
Associate Fellow in Roentgenology of the International College of Surgeons
Fellow, American Medical Association
Diplomate, American Board of Radiology
Honorary Degree, M.S., Ohio Wesleyan University, 1919
Honorary Degree, D.Sc., American University, 1943
Honorary Fellow, Faculty of Radiologists, 1950, Great Britain
President, Fifth International Congress of Radiology
Past President, The American Board of Radiology
Past President, American College of Radiology
Member and Past President, American Roentgen Ray Society
Member and Past President, Medical Society of District of Columbia
Member, Radiological Society of North America
Honorary Member, Societas Radiologiae Medicae Italica
Honorary Member, Deutsche Röntgen-Gesellschaft
Honorary Member, Osterreichische Gesellschaft für Röntgenkunde und Strahlenforschung
Honorary Member, Nordisk Forening for Medicinsk Radiologi
Honorary Member, British Institute of Radiology
Honorary Fellow, Southeastern Surgical Congress
Editor, American Journal of Roentgenology and Radium Therapy, 1924–1929
Medical Department, U. S. Army, First Lieutenant and Captain, 1907–1916
Major, Medical Corps, United States Army, 1917
Colonel, Medical Corps, United States Army, 1918
Colonel, Medical Reserve Corps, United States Army
Chief, Division of Roentgenology, Medical Department, U. S. Army, May 1917 to August 1918
Senior Consultant in Roentgenology, A.E.F., France, October 1918 to February 1919
Consultant in Radiology, Diagnostic Center, Veter-

ans Administration, Washington, D. C. 1920–1936
Member, Medical Advisory Group, Veterans Administration 1946–1952
Consultant in Radiology, Army Medical Center, Washington, D. C. 1946–1950
Consultant, Tuberculosis Division, U. S. Public Health Service
Professor of Roentgenology and Operative Surgery, Army Medical School, 1912–1916
Professor of Roentgenology, Medical School, George Washington University, 1919–1932
Professor of Clinical Radiology, Georgetown University School of Medicine, 1929–1946
Member, The Committee on the Cost of Medical Care, 1927–1932
Chairman, Committee on Radiology, National Research Council, 1940–1946
Member, Citizens Medical Advisory Committee to Commissioners, District of Columbia, 1952
Chief, Department of Radiology, Doctors Hospital, Washington, D. C., 1939 to present time
Member, Board of Trustees, Metropolitan Methodist Church, Washington, D.C.
Past President, Board of Trustees, The American University
Past President, Board of Trustees, Swartzell Home for Children
Member and Past President, Washington Y.M.C.A.
Member and Past President, Washington Rotary Club
Member, Board of Directors, Group Hospitalization, Inc.
Member, Army and Navy Club
Member, Albert Pike Consistory, Washington, D. C.
Member American Legion, Norman Price Post, Sandy Spring, Maryland
Author of numerous papers on the use of the roentgen rays in diagnosis and treatment and numerous papers on medical economics. Also:
"Roentgen Diagnosis and Therapy," J. B. Lippincott, 1924
"Economic Problems of Medicine," Macmillan, 1935
Britannica Book of the Year—X-ray section 1937 through 1951

ARTHUR WRIGHT ERSKINE
1885-1952

DR. ARTHUR WRIGHT ERSKINE of Cedar Rapids, Iowa, died on December 10, 1952, of a cerebral hemorrhage.

He received his preparatory work at Hiram College, Ohio, and his M.D. degree from Baltimore Medical College in 1908. He interned at Maryland General Hospital, Baltimore, and did special work at Johns Hopkins University. He was in general practice in Bessemer, Pennsylvania, until 1912 when he came to Cedar Rapids to practice radiology, maintaining an office

and heading the departments at Mercy Hospital and St. Luke's Hospital. Dr. Erskine was married on August 24, 1916, to Betsy Smith, who survives him.

He was particularly interested in the therapeutic aspects of radiology and its application to the treatment of cancer. His more than forty papers on the subject, his well known book, "Practical X-ray Treatment," his collaboration in writing the Iowa Cancer Manual distributed to the physicians of Iowa, Pennsylvania and New York, and his development of the speculum for transvaginal treatment of cancer of the cervix, all attest to this fact and won for him the medal of the Iowa Division of the American Cancer Society in 1952 "for distinguished service in cancer control."

He was particularly proud not only of the part he played in early roentgen-ray measurements[1,2] (his first measuring apparatus "being made from an old cigarette box, a salvarsan can, a length of gas tubing and a piece of lead pipe") but also of his work with the committee appointed to name and adopt an international unit of roentgen-ray measurement.

During his early experimental work he suffered radiation injuries to his right hand, necessitating more than thirty operations and the eventual loss of all but the thumb and little finger. This injury delayed his being accepted in the Medical Corps of the Army in World War I. After two rejections, he eventually received his commission as First Lieutenant, but he was not called for service.

Dr. Erskine was a diplomate of the American Board of Radiology and was a member and held office in many medical societies. He was co-founder of the Iowa X-ray Club and its secretary from 1920 to 1952, President of the Linn County Medical Society in 1920, became a member of the American Roentgen Ray Society in 1921, President of the Radiological Society of North America in 1925, President of the Iowa State Medical Society in 1938, President of the American College of Radiology in 1950, and a member of its Board of Censors from 1950 to 1952. Space does not permit elaboration of his many committee activities and constructive efforts in behalf of organized medicine.

In his hobby of wood carving, as in his profession, Dr. Erskine also excelled. He received a silver cup from the American Physicians Art Association, Class A, for his carving of a panther exhibited at the annual session of the American Medical Association in 1944.

The American Roentgen Ray Society is indeed fortunate to have a historic gavel carved and presented to the Society by him at its Forty-seventh Annual Meeting held in Cincinnati in 1946. To quote from the Society proceedings of this meeting:[3] "This unique gavel was handmade by Dr. Erskine and consists of the wooden base of Röntgen's microscope—the head of the gavel; a piece of the roll top desk Dr. W. D. Coolidge used during the years he worked on the roentgen tube and ductile tungsten for lamps makes up the handle of the gavel. The block and its mahogany inlay with a sine wave making up the sounding board are part of one of the early Snook machines. It can be seen even from this brief description that the word 'unique' was used advisedly for it is beyond the realm of probability that wood from such historical materials could be made available for another gavel or that it would have the handicraft of Dr. Erskine for its fashioning."

He was the just arbitrator in many intraprofessional dissensions and was always the champion of the younger and untried physician. His philanthropies to children, to the unfortunate, and to deserving college students were not generally known for Dr. Erskine was a modest though generous man.

[1] Erskine, Arthur W. Homogeneous radiation of the chest. *J. Radiol.*, 1922, *3*, 5–8.

[2] Erskine, Arthur W. Practical application of ionization measurements of x-rays. *J. Radiol.*, 1922, *3*, 169–173.

[3] Am. J. Roentgenol. & Rad. Therapy, 1946, *56*, 540.

He had the rare ability of imparting to his patients the knowledge that while being examined or treated by him, their welfare was his only concern.

Dr. Erskine lived a full and productive life, giving much and asking little, a true physician loved and trusted by his patients, honored and esteemed by the members of his profession. He was granted his one wish—to die quickly and without suffering.

SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

MEETINGS OF ROENTGEN SOCIETIES*

United States of America

American Roentgen Ray Society
Secretary, Dr. Barton R. Young, Germantown Hospital, Philadelphia 44, Pa. Annual meeting: Netherland Plaza Hotel, Cincinnati, Ohio, Sept. 29–Oct. 2, 1953.

American Radium Society
Secretary, Dr. J. E. Wirth, 635 Herkimer St., Pasadena 1, Calif. Annual meeting: Chase Hotel, St. Louis, Mo., April 20–22, 1953.

Radiological Society of North America
Secretary, Dr. D. S. Childs, 713 E. Genesee St., Syracuse 2, N. Y. Annual meeting: 1953, to be announced.

American College of Radiology
Executive Secretary, William C. Stronach, 20 N. Wacker Drive, Chicago 6, Illinois.

Section on Radiology, American Medical Association
Secretary, Dr. T. Leucutia, Harper Hospital, Detroit 1, Mich. Annual meeting: New York, New York, June 1–5, 1953.

Alabama Radiological Society
Secretary, Dr. J. A. Meadows, Jr., Medical Arts Bldg., Birmingham 5, Ala. Meets time and place Alabama State Medical Association.

Arizona Radiological Society
Secretary, Dr. R. Lee Foster, 15 E. Monroe, Phoenix, Ariz. Two regular meetings a year. The annual meeting at time and place of State Medical Association and interim meeting six months later.

Arkansas Radiological Society
Secretary, Dr. Fred Hames, 511 National Bldg., Pine Bluff, Ark. Meets every three months and also at time and place of State Medical Association.

Atlanta Radiological Society
Secretary, Dr. Albert A. Rayle, Jr., 478 Peachtree St., N.E., Atlanta, Ga. Meets monthly, except during three summer months, on second Friday evening.

Brooklyn Roentgen Ray Society
Secretary, Dr. J. J. Daversa, 345 75th St., Brooklyn, N. Y. Meets monthly fourth Tuesday, October through April.

Buffalo Radiological Society
Secretary, Dr. Mario C. Gian, 610 Niagara St., Buffalo, N. Y. Meets second Monday evening each month, October to May inclusive.

Central New York Roentgen Ray Society
Secretary, Dr. Dwight V. Needham, 608 E. Genesee St., Syracuse N. Y. Meets January, May, November.

Central Ohio Radiological Society
Secretary, Dr. F. A. Riebel, 15 West Goodale St., Columbus, Ohio. Meets at 6:30 P.M. on second Thursday of October, December, February, April, and June at Columbus Athletic Club, Columbus, Ohio.

Chicago Roentgen Society
Secretary, Dr. Elbert K. Lewis, 6337 S. Harvard Ave., Chicago, Ill. Meets second Thursday of each month, October to April inclusive at the University Club.

Cleveland Radiological Society
Secretary, Dr. Mortimer Lubert, 10515 Carnegie Ave., Cleveland 6, Ohio. Meetings at 6:45 P.M. on fourth Monday of each month from October to April.

Colorado Radiological Society
Secretary, Dr. William Curtis, 1612 Tremont, Denver, Colo. Meets third Friday of each month at University of Colorado Medical Center or at Denver Athletic Club.

Connecticut Valley Radiologic Society
Secretary, Dr. E. W. Godfrey, 1676 Boulevard, West Hartford, Conn. Meets second Friday October and April.

Dallas-Fort Worth Roentgen Study Club
Secretary, Dr. X. R. Hyde, Medical Arts Bldg., Fort Worth, Texas. Meets in Dallas on odd months and in Fort Worth on even months, on third Monday, 7:30 P.M.

Detroit Roentgen Ray and Radium Society
Secretary, Dr. J. C. Cook, Harper Hospital, Detroit, Mich. Meets monthly first Thursday, October to May, at Wayne County Medical Society Building.

East Bay Roentgen Society
Secretary, Dr. Dan Tucker, 434 30th St., Oakland 9, Calif. Meets first Thursday each month at Peralta Hospital, Oakland.

Florida Radiological Society
Secretary, Dr. A. Judson Graves, 2002 Park St., Jacksonville, Fla. Meets twice annually, in the spring with the annual State Society meeting, and in the fall.

Georgia Radiological Society
Secretary, Dr. Robert M. Tankesley, 218 Doctors Bldg., Atlanta, Ga. Meets in mid-winter and at annual meeting of Medical Association of Georgia in the spring.

Greater Miami Radiological Society
Secretary, Dr. Maurice Greenfield, Ingraham Bldg., Miami, Fla. Meets third Wednesday of each month at Veterans Administration Building.

Houston Radiological Society
Secretary, Dr. F. M. Windrow, 1205 Hermann Professional Bldg., Houston, Texas. Meets fourth Monday each month.

Idaho State Radiological Society
Secretary, Dr. Alfred M. Stone, St. Lukes Hospital, Boise, Idaho. Meets annually at same time as Idaho State Medical Association.

Illinois Radiological Society
Secretary, Dr. Stephen L. Casper, 1101 Maine St., Quincy, Ill. Meets three times a year.

Indiana Roentgen Society
Secretary, Dr. William M. Loehr, 712 Hume-Mansur Bldg., Indianapolis 4. Meets second Sunday in May.

Iowa X-Ray Club
Secretary, Dr. James McMillan, 1104 Bankers Trust Bldg., Des Moines, Iowa. Luncheon and business meeting during annual session of Iowa State Medical Society. The scientific section is held in the autumn.

Kansas Radiological Society
Secretary, Dr. Willis L. Beeler, M.D., 700 Kansas Ave., Topeka, Kansas. Meets in spring with State Medical Society, and in winter on call.

Kentucky Radiological Society
Secretary, Dr. E. L. Pirkey, Louisville General Hospital, Louisville 2, Ky. Meets monthly on second Friday at Seelbach Hotel, Louisville.

Kings County Radiological Society
Secretary, Dr. Marcus Wiener, 1430 48th St., Brooklyn, N. Y. Meets Kings County Med. Soc. Bldg. monthly on fourth Thursday, October to May, 8:45 P.M.

Los Angeles Radiological Society
Secretary, Dr. Joseph F. Linsman, 436 N. Roxbury Dr., Beverly Hills, Calif. Meets second Wednesday each month at Los Angeles County Medical Association Building, Los Angeles.

Louisiana Radiological Society
Secretary, Dr. J. R. Anderson, 1130 Louisiana Ave., Shreveport. Meets annually during Louisiana State Medical Society Meeting.

* Secretaries of societies are requested to send timely information promptly to the Editor.

Maine Radiological Society
Secretary, Dr. Hugh Allan Smith, Eastern Maine General Hospital, Bangor, Maine. Meets in early spring, June and fall.

Miami Valley Radiological Society
Secretary, Dr. G. A. Nicoll, 134 Apple St., Dayton, Ohio. Meets second Friday of fall and winter months.

Mid-Hudson Radiological Society
Secretary, Dr. J. W. Walton, Horton Memorial Hospital, Middletown, N. Y. Meets 8:30 P.M., fourth Tuesday each month, September to May.

Milwaukee Roentgen Ray Society
Secretary, Dr. T. J. Pfeffer, 839 N. Marshall St., Milwaukee 2, Wis. Meets monthly on second Monday at University Club.

Minnesota Radiological Society
Secretary, Dr. John R. Hodgson, Mayo Clinic, Rochester, Minn. Meets three times annually, once at time of State Med. Assn., and in spring and fall.

Mississippi Radiological Society
Secretary, Dr. John W. Evans, 117 N. President St., Jackson, Miss. Meets third Thursday of each month at the Rotisserie Restaurant at 6:30 P.M.

Montana Radiological Society
Secretary, Dr. Grant P. Raitt, Suite 413 Medical Arts Bldg., Billings, Montana. Will meet at least once a year.

Nassau Radiological Society
Secretary, Dr. Joseph J. La Vine, 259 North Grand Ave., Baldwin, N. Y. Meets second Tuesday of the month in February, April, June, October and December.

Nebraska Radiological Society
Secretary, Dr. R. W. Blanchard, 1216 Medical Arts Bldg., Omaha, Nebr. Meets fourth Thursday of each month at 6 P.M. at Omaha or Lincoln.

New England Roentgen Ray Society
Secretary, Dr. Stanley M. Wyman, Massachusetts General Hospital, Boston, Mass. Meets monthly on third Friday, Harvard Club.

New Hampshire Roentgen Ray Society
Secretary, Dr. A. C. Johnston, Elliott Community Hospital, Keene, N. H. Meets four to six times yearly.

New York Roentgen Society
Secretary, Dr. Harold W. Jacox, 622 W. 168th St., New York 32, N. Y. Meets monthly on third Monday, New York Academy of Medicine, at 8:30 P.M.

North Carolina Radiological Society
Secretary, Dr. J. E. Hemphill, 1420 E. Fifth St., Charlotte 4, N. C. Meets in May and October.

North Dakota Radiological Society
Secretary, Dr. C. O. Heilman, 807 Broadway, Fargo. Meetings by announcement.

Northeastern New York Radiological Society
Secretary, Dr. John F. Roach, Albany Hospital, Albany, N. Y. Meets in Albany area on second Wednesdays of October, November, March and April. Annual meeting will be held in May or June, 1953.

Northern California Radiological Society
Secretary, Dr. Richard C. Ripple, 1215 28th Street, Sacramento, Calif. Meets at dinner last Monday of September, November, January, March and May.

Ohio State Radiological Society
Secretary, Dr. Willis S. Peck, 1838 Parkwood Ave., Toledo 2, Ohio.

Oklahoma State Radiological Society
Secretary, Dr. John R. Danstrom, Medical Arts Bldg., Oklahoma City, Okla. Three regular meetings annually.

Oregon Radiological Society
Secretary, Dr. J. Richard Raines, 214 Medical-Dental Bldg., Portland 5, Oregon. Meets monthly from October to June on the second Wednesday of each month at 8:00 P.M. at the University Club.

Orleans Parish Radiological Society
Secretary, Dr. Joseph V. Schlosser, Charity Hospital, New Orleans 13, La. Meets first Tuesday of each month.

Pacific Northwest Radiological Society
Secretary, Dr. S. J. Hawley, 1320 Madison St., Seattle 4, Wash. Meets annually in May.

Pacific Roentgen Society
Secretary, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif. Meets annually, during meeting of California Medical Association.

Pennsylvania Radiological Society
Secretary, Dr. J. M. Converse 416 Pine St., Williamsport.

Philadelphia Roentgen Ray Society
Secretary, Dr. George P. Keefer, American Oncologic Hospital, Philadelphia 4, Pa. Meets first Thursday of each month, at 5 P.M., from October to May in Thompson Hall, College of Physicians.

Pittsburgh Roentgen Society
Secretary, Dr. Donald H. Rice, Western Pennsylvania Hospital, Pittsburgh 24, Pa. Meets 6:00 P.M. at Webster Hall Hotel on second Wednesday each month, October to May inclusive.

Radiological Section, Baltimore Medical Society
Secretary, Dr. H. Leonard Warres, 2337 Eutaw Place, Baltimore 17, Md. Meets third Tuesday each month, September to May, inclusive.

Radiological Section, Connecticut Medical Society
Secretary, Dr. William A. Goodrich, 85 Jefferson St., Hartford 6, Conn. Meetings are held bi-monthly.

Radiological Section, Medical Society of the District of Columbia
Secretary, Dr. U. V. Wilcox, 915 Nineteenth St., N. W., Washington 6, D. C. Meets Medical Society Library, third Thursday of January, March, May and October at 8:00 P.M.

Radiological Section, Southern Medical Association
Secretary, Dr Roy G. Giles, Temple, Texas.

Radiological Society of Greater Cincinnati
Secretary, Dr. Harry K. Hines, 2508 Auburn Ave., Cincinnati 19, Ohio. Meets monthly from September to June on first Monday of each month at 7:30 P.M. at the Cincinnati General Hospital.

Radiological Society of Hawaii
Secretary, Colonel Alexander O. Haff, M.C., Tripler Army Hospital, Honolulu, T. H. Meets third Friday of each month at Tripler Army Hospital.

Radiological Society of Kansas City
Secretary, Dr. Arthur B. Smith, 800 Argyle Bldg., Kansas City, Mo. Meets third Thursday of each month.

Radiological Society of New Jersey
Secretary, Dr. Nicholas G. Demy, 912 Park Avenue, Plainfield, N. J. Meets annually at Atlantic City at time of State Medical Society and mid-winter at Elizabeth, N. J.

Richmond County Radiological Society
Secretary, Dr. W. F. Hamilton, Jr., University Hospital, Augusta, Ga.

Rochester Roentgen Ray Society, Rochester, N. Y.
Secretary, Dr. A. Gordon Ide, 277 Alexander St., Rochester 7, N. Y. Meets at 8:15 P.M. on the last Monday of each month, September through May, at Strong Memorial Hospital.

Rocky Mountain Radiological Society
Secretary, Dr. Maurice D. Frazer, 1037 Stuart Bldg., Lincoln, Nebr. Next annual meeting, Shirley-Savoy Hotel, Denver, Colo., August 20, 21 and 22, 1953.

St. Louis Society of Radiologists
Secretary, Dr. Francis O. Trotter, Jr., 634 N. Grand Blvd., St. Louis 3, Mo. Meets fourth Wednesday each month, except June, July, August and September.

San Antonio-Military Radiological Society
Secretary, Dr. Hugo F. Elmendorf, Jr., 730 Medical Arts Bldg., San Antonio 5, Texas. Meets Brook Army Medical Center Officers Mess first Monday of each month.

San Diego Radiological Society
Secretary, Dr. C. W. Bruner, 2456 Fourth Ave., San Diego 1, Calif. Meets first Wednesday of each month at the University Club.

San Francisco Radiological Society
Secretary, Dr. I. J. Miller, 2680 Ocean Avenue, San Francisco 27, Calif. Meets quarterly.

Section on Radiology, California Medical Association
Secretary, Dr. Calvin L. Stewart, 2330 First Ave., San Diego 1, Calif.

Section on Radiology, Illinois State Medical Society
Secretary, Dr. George E. Irwin, Jr., 703 N. East St., Bloomington, Ill.

Shreveport Radiological Club
Secretary, Dr. R. W. Cooper, Charity Hospital, Shreveport, La. Meets monthly on third Wednesday, at 7:30 P.M., September to May inclusive.

South Bay Radiological Society
Secretary, Dr. Ford Shepherd, 526 Soquel Avenue, Santa Cruz, Calif. Meets second Wednesday each month.

South Carolina Radiological Society
Secretary, Dr. Henry E. Plenge, Spartanburg General Hospital, Spartanburg, S. C. One meeting with South Carolina Medical Association in May, others arranged by President.

Tennessee Radiological Society
Secretary, Dr. J. M. Frère, Newell Hospital, Chattanooga, Tenn. Meets annually at the time and place of the Tennessee State Medical Association.

Texas Radiological Society
Secretary, Dr. R. P. O'Bannon, 650 Fifth Ave., Fort Worth 4, Texas.

University of Michigan Department of Roentgenology Staff Meeting
Meets each Monday evening from September to June, at 7:00 P.M. at University Hospital.

University of Wisconsin Radiological Conference
Secretary, Dr. E. A. Pohle, 1300 University Ave., Madison, Wis. Meets first and third Thursdays 4:00 to 5:00 P.M., September to May, Service Memorial Institute.

Utah State Radiological Society
Secretary, Dr. Angus K. Wilson, 343 S. Main St., Salt Lake City 1, Utah. Meets third Wednesday in September, November, January, March and May.

Virginia Radiological Society
Secretary, Dr. P. B. Parsons, Norfolk General Hospital, Norfolk, Va. Meets annually in October.

Washington State Radiological Society
Secretary, Dr. John N. Burkey, 555 Medical-Dental Bldg., Seattle 1, Wash. Meets fourth Monday of each month from September through May.

Westchester Radiological Society
Secretary, Dr. Clifford C. Baker, Harwood Bldg., Scarsdale, N. Y. Meets on third Tuesdays of January and October and on two other dates.

Wisconsin Radiological Society
Secretary, Dr. Irving I. Cowan, 425 E. Wisconsin Ave., Milwaukee 2, Wis. Special meetings held during year; annual meeting each spring at Madison, Wis.

X-Ray Study Club of San Francisco
Secretary, Dr. Wm. W. Saunders, Veterans Administration Hospital, San Francisco 21, Calif. Meets monthly, third Thursday, at 7:45 P.M., Lane Hall, Stanford University Hospital.

Cuba, Mexico and Central America

Sociedad de Radiología y Fisioterapia de Cuba
President, Dr. J. Manuel Viamonte, Hospital Mercedes, Habana, Cuba. Meets monthly in Habana.

Sociedad Mexicana de Radiologia y Fisioterapia
General Secretary, Dr. D. P. Cossio, Marsella No. 11, Mexico, D. F. Meets first Monday of each month.

Sociedad Radiológica Panameña
Secretary, Dr. L. Arrieta Sanchez, Apartado No. 86, Panama, R. de P. Meets monthly in a department of radiology of a local hospital, chosen at preceding meeting.

British Empire

British Institute of Radiology Incorporated with the Röntgen Society
Ordinary meeting, on the Thursday preceding the third Friday, October to May at 8:15 P.M.
Medical Members' meeting, on third Friday in each month at 5:00 P.M., 32 Welbeck St., London, W 1.

Faculty of Radiologists
Honorary Secretary, Dr. J. F. Bromley, 45, Lincoln's Inn Fields, London, W.C.2, England.

Section of Radiology of the Royal Society of Medicine (Confined to Medical Members)
Meets third Friday each month at 4:45 P.M. at the Royal Society of Medicine, 1 Wimpole St., London.

Canadian Association of Radiologists
Honorary Secretary-Treasurer, Dr. Jean Bouchard, Suite 305, 1555 Summerhill Avenue, Montreal 26, Que. Meetings January and June.

Section of Radiology, Canadian Medical Association
Secretary, Dr. C. M. Jones, Inglis St., Ext. Halifax, N. S.

Société Canadienne-Française d'Electrologie et de Radiologie Médicales
Secretary, Dr. Origéne Dufresne, 4120 Ontario St., East, Montreal, P. Q.

College of Radiologists (Australia and New Zealand)
Honorary Secretary, Dr. Alan R. Colwell, c/o British Medical Agency, 135 Macquarie St., Sydney, N.S.W.

South America

Asociacion Argentina de Radiologia
Secretary, Dr. Lidio G. Mocsa, Avda. Gral. Paz 151, Córdoba, Argentina. Meetings held monthly.

Sociedad Argentina de Radiologia, Junta Central, Buenos Aires
Secretary, Dr. Oscar F. Noguera, Santa Fe 1171, Buenos Aires. Meetings are held monthly.

Sociedad Argentina de Radiologia, Filial del Litoral, Sede, Rosario
President, Dr. Francisco P. Cifarelli. Meets monthly second Wednesday, 19 ha 663 Italia St., Rosario, Santa Fe.

Sociedad Argentina de Radiologia, Filial del Sur, Sede, La Plata
President, Prof. Dr. Jose P. Uslenghi, La Plata. Meets monthly.

Sociedad Argentina de Radiologia, Filial del Centro Sede, Cordoba
President, Prof. Dr. David L. Caro, Corro 86, Cordoba. Meets monthly.

Sociedad Argentina de Radiologia, Filial del Norte, Sede, Tucuman
President, Dr. Julio Mendez Valladares, Rivadavia 358, Tucuman. Meets monthly.

Sociedad Argentina de Radiologia, Filial de Cuyo Sede, Mendoza.
President, Dr. J. A. Orfila, Hospital Central, Mendoza. Meets monthly.

Sociedade Brasileira de Radiologia Medica
Secretary, Dr. Nicola Caminha, Av. Mem de Sa, Rio de Janeiro, Brazil. Meets monthly, except during January, February and March.

Sociedade Brasileira de Radioterapia
Secretary, Dr. Oscar Rocha von Pfuhl, Av. Brigadeiro Luiz Antonio, 644 São Paulo, Brazil. Meets monthly on second Wednesday at 9:00 P.M. in São Paulo at Av. Brigadeiro Luiz Antonio, 644.

Sociedad Colombiana de Radiologia
Secretary, Dr. Luis E. Lozano B., Carrera 12 No. 20–69, 6º piso, Bogota, Colombia. Meets last Thursday of each month.

Sociedad Peruana de Radiologia
Secretary, Dr. Julio Bedoya Paredes, Apartado 2306, Lima, Peru. Meets monthly except during January, February and March, at Asociación Médica Peruana "Daniel A. Carrión," Villalta, 218, Lima.

Sociedad de Radiologica, Cancerologia y Fisica Medica del Uruguay
Secretary, Dr. Arias Bellini, Av. Agraciada 1464, Piso 13, Montevideo, Uruguay.

Continental Europe

Société Belge de Radiologie
General Secretary, Dr. S. Masy, 111 Avenue des Allies, Louvain, Belgium. Meets monthly, second Sunday at Maison des Médecins, Brussels.

Société Française d'Electro-Radiologie Médicale, and its branches: Société du Sud-Ouest, du Littoral Méditerranéen, du Centre et du Lyonnais, de l'Ouest, de l'Est, et d'Alger et d'Afrique du Nord
Secretary-General, Dr. A. Dariaux, 9 bis, Boulevard Rochechouart, Paris IX°, France.

Ceskoslovensk společnost pro rëntgenologii a Radiologii v Praze
Secretary, Dr. Roman Bláha, Praha XII, stát. nemocnice, Czechoslovakia. Meets monthly except during July, August, and September. Annual general meeting.

Polish Society of Radiology
Secretary, Dr. L. Zgliczynski, 59 Nowogrodzka St., Warsaw, Poland.

Gdansk Section, Polish Society of Radiology
Secretary, Dr. A. Smigielska, Akademia Lekarska, Gdansk. Meets monthly last Sunday at 10:30, X-Ray Dept., Akademia Gdansk.

Wrocław Section Polish Society of Radiology
Secretary, Dr. R. Marciniak, Akad. Medyczna Wrocław, 68 Curie-Skłodowska St., Wrocław, Poland. Meets first Sunday of each month, X-Ray Department, Akademia Medyczna Wrocław.

Societatea Romana de Radiologie si Electrologie
Secretary, Dr. Oscar Meller, Str. Banual Mărăcine, 30, S. I., Bucuresti, Roumania. Meets second Monday in every month with the exception of July and August.

All-Russian Roentgen Ray Association, Leningrad
USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.
Secretaries, Drs. S. A. Reinberg and S. G. Simonson. Meets annually.

Scandinavian Roentgen Societies
The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association.

Sociedad Espanola de Radiologia y Electrologia
Secretary, Dr. J. Martin-Crespo, Fuencarral, 7. Madrid, Spain. Meets monthly in Madrid.

Schweizerische Röntgen-Gesellschaft (Société Suisse de Radiologie)
Secretary, Dr. Max Hopf, Effingerstrasse 47, Bern, Switzerland.

Deutsche Roentgen-Gesellschaft
Secretary, Dr. Peter Kröker, (22a) Essen-Helsingen, Westpreussenstrasse 21. Meets annually in different towns.

Societa Italiana di Radiologia Medica
Secretary, Prof. Mario Ponzio, Ospedale Mauriziano. Torino, Italy. Meets biannually.

India

Indian Radiological Association
Secretary, Dr. R. F. Sethna, Navsari Building, Hornby Road, Bombay 1, India.

COURSE IN INDUSTRIAL USES OF RADIOISOTOPES

The first advanced course in *industrial uses of radioisotopes*, an advanced course in *radioautography*, and three more basic *radioisotope techniques courses* will constitute the spring and summer course offerings of the Special Training Division, Oak Ridge Institute of Nuclear Studies.

In addition, the Division will on April 30 and May 1, 1953, give a symposium on "Management Problems in the Industrial Application of Radioisotopes." Management personnel of companies interested in incorporating radioisotopes or other atomic energy products into their research or production activities are invited to attend the symposium, which will be devoted to those special problems imposed on management by the use of these materials. Speakers who have coped with these problems successfully will be the symposium leaders. Subjects to be covered will include dealing with the Atomic Energy Division (contracts, information sources, available products and other services available from AEC), legal problems encountered in radioisotope use, insurance problems, public relations, the role of consulting laboratories, safety and procurement of radioisotopes, and the equipping and staffing of radioisotope laboratories.

Dates for the course offerings are as follows:

Industrial use of radioisotopes—April 20–May 1, 1953

Radioautography course—June 15–26, 1953

Basic courses lasting for four weeks will begin on June 8, July 6, and August 10, 1953.

The industrial course will offer instruction in a number of techniques which have become important in research or production. These include wear studies, gauging procedures and devices, radiography, isotope marking process, industrial processes, chemical reaction studies, analytical chemistry applications, isotopes in the biological industries, textile and laundering problems, instrumental developments, and industrial radioautography. Emphasis will be on techniques involved rather than actual results.

Specialists in this field will conduct various phases of the course in radioautography which is intended for research-level personnel. George A. Boyd will be the course director.

Additional information and information blanks may be obtained from the Special Training Division, Oak Ridge Institute of Nuclear Studies, P. O. Box 117, Oak Ridge, Tennessee.

COURSE IN THE ESSENTIAL PHYSICS OF RADIOLOGY

A course (No. 882) in the essential physics of radiology will be presented by the Division of Medical Extension Education of the University of Southern California School of Medicine beginning March 9, 1953. The course will be given at the Los Angeles County Hospital March 9–April 13 and at the Cedars of Lebanon Hospital April 13–May 25, 1953. The tuition is $50.00. The speakers are Robert E. Pugh, Jr., Roentgen Ray and Radium Physicist; Robert M. Sodaro, Health Physicist; Henry L. Jaffe, M.D., Associate Clinical Professor of Radiology (Therapeutic).

This course should be of interest to those in the field of radiology and radioisotopes. Complete information concerning the course may be obtained from Dr. Gordon E. Goodhart, Director, Medical Extension Education, 1200 North State Street, Los Angeles 33, California.

AMERICAN ACADEMY OF NEUROLOGY

ANNOUNCEMENT OF SPECIAL COURSES

The American Academy of Neurology is again offering special courses in various aspects of neurology and allied disciplines. The popularity of the courses given in previous years has resulted in offering nine courses this year. Courses in Neuropathology and Clinical Electroencephalography are being repeated, as is the course in Neuroroentgenology. The latter course has proved so popular that it will be presented as a two day course this year because of the wealth of material. Other courses to be presented this year are Special Problems in Clinical Electroencephalography, Episodic Disturbances of the Nervous System, Clinical Neuro-ophthalmology, Language Disabilities, Brain Tumors and Neurological Anatomy.

These courses are oriented toward practical clinical use for the one who is establishing a basic foundation and for the one looking for advanced knowledge. The faculty has been selected, many from the allied specialties, for the recognized leadership in their field and for their teaching ability.

Fees are moderate and many courses offer atlases, loan-boxes of slides, syllabi, discussion sessions, etc. Modern projection techniques will be used to demonstrate material. Courses will be one day courses except, as mentioned above, the two day course in Neuroroentgenology. There will be three days (April 6, 7, 8, 1953) of special courses preceding the Fifth

Annual Meeting of the Academy. Courses and meeting will be held at the Edgewater Beach Hotel, Chicago, Illinois. Details can be obtained by writing Mrs. J. C. McKinley, 19 Millard Hall, University of Minnesota, Minneapolis, Minnesota.

KENTUCKY RADIOLOGICAL SOCIETY

At the January meeting of the Kentucky Radiological Society, the following were elected officers for the coming year: *President*, Dr. Jesshill Love; *Vice-President*, Dr. H. L. Townsend; *Secretary-Treasurer*, Dr. Everett L. Pirkey, Louisville General Hospital, Louisville, Kentucky.

ROCHESTER ROENTGEN RAY SOCIETY

The following is a list of the recently elected officers of the Rochester (New York) Roentgen Ray Society: *President*, Dr. George Gamsu; *Vice-President*, Dr. Robert J. Bloor; *Secretary-Treasurer*, Dr. A. Gordon Ide, 277 Alexander St., Rochester, New York. The Society meets at 8:15 P.M. on the last Monday of each month, September through May, at Strong Memorial Hospital.

WESTCHESTER RADIOLOGICAL SOCIETY

The newly elected officers of the Westchester Radiological Society for 1953 are as follows: *President*, Dr. Anthony Debbie, Valhalla, N. Y.; *Secretary*, Dr. Clifford C. Baker, Harwood Bldg., Scarsdale, N. Y.; *Treasurer*, Dr. Fred H. Lutze, New Rochelle, N. Y.

SOCIEDAD COLOMBIANA DE RADIOLOGIA

The newly elected officers of the Sociedad Colombiana de Radiologia for the coming year are as follows: *President*, Dr. Mario Gaitán Yanguas; *Vice-President*, Dr. Julio Medina Medina; *Secretary*, Dr. Luis E. Lozano B., Carrera 12 No. 20–69, 6° piso, Bogotá, Colombia, S. A. Meetings are held monthly on the last Thursday of each month.

BOOK REVIEWS

Books sent for review are acknowledged under: Books Received. This must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interest of our readers as space permits.

THE NORMAL ENCEPHALOGRAM. By Leo M. Davidoff, M.D., Director of Neurological Surgery, Beth Israel Hospital, New York City; Clinical Professor of Neurosurgery, New York University Postgraduate Medical School; and Cornelius G. Dyke, M.D., Late Associate Professor of Radiology in the College of Physicians and Surgeons, Columbia University; Late Director, in the Department of Radiology of the Neurological Institute of New York, New York City. Third edition, thoroughly revised by Leo M. Davidoff, M.D. Cloth. Price, $6.00. Pp. 240, with 156 illustrations. Lea & Febiger, Washington Square, Philadelphia 6, Pennsylvania, 1951.

In two hundred and eight pages of well organized and clearly written text, the authors of this newly edited classic provide a thorough and highly practical atlas of intracranial anatomy as it is brought to light by means of the introduction of gas into the subarachnoid space and the ventricular system. Since the appearance of the first and second editions, valuable experience regarding the procedure as tolerated by patients has been brought together from a large number of sources and a considerable array of variations in technique have been described and thoughtfully discussed. Anatomical considerations in this difficult field are presented in superlative fashion, using to great advantage reproductions of roentgenograms, photographs of brain specimens, and well executed drawings—whichever medium best serves the purpose of clarification.

The volume is an excellent example of book making. The table of contents, the rich and carefully selected bibliography, and the index make all parts of the text quickly available to the student or to the practitioner who wishes to refresh his knowledge concerning some particular point. The reproductions are of high quality, which is so important in this particular field.

In its new form "The Normal Encephalogram" is more than ever a valued companion and servant for those who are engaged in any form of intracranial aerography.

FRED J. HODGES, M.D.

X-RAY INTERPRETATION. By H. Cecil H. Bull, M.A., M.B., M.R.C.P., Honorary Consulting Radiologist to the Royal Waterloo Hospital, London, and the General Hospital, Southend-on-Sea. With a chapter on Radiography of the Head by James W. D. Bull, M.A., M.B., M.R.C.P., D.M.R., Assistant Radiologist, St. George's Hospital; Radiologist, Maida Vale Hospital for Nervous Diseases; Assistant Radiologist, National Hospital. Second edition. Cloth. Price, $5.50. Pp. 406, with 287 original illustrations by the author. Oxford University Press, 114 Fifth Avenue, New York 11, New York, 1951.

This little book is directed to all who are interested in the use of roentgen rays as an aid to clinical diagnosis, but its total appeal will be to a rather limited group. It is fundamentally a primer in the science of roentgenology, but it is written for one with a complete background in general medicine. The author's style is clear, lively, and charming. An interesting and unusual feature is the absence of reproduced roentgenograms. The illustrations are all line drawings, and these are excellent for depicting the points in the author's discussion, if one is acquainted with the actual appearance of the roentgenogram, or if one has a film available for comparison.

Many of the subjects receive suitable, rather elementary treatment, while others are discussed more at length. In a relatively thorough discussion of the gastrointestinal tract, there is only superficial mention of the problems encountered in children, including congenital abnormalities. In the brief treatment of the spine are some statements which are not universally accepted, and the section on the arthritides is relatively shorter than the discussion of some rarer conditions. Considerable space is given to technical problems which would be of interest to radiologists and roentgenographers; the remainder of the book is too elementary for the former or too profound medically for the latter. In each chapter there is a description of the normal appearance of each portion of the body preceding the discussion of the pathological changes.

In view of the audience at which the author

aims, a very important and valuable portion of the book is that which deals with the relationship between clinicians and roentgenologists and with the attitudes of the radiologist toward the patient. The author explains throughout the book, in discussing various points, the value of cooperation between clinician and roentgenologist. Also of considerable importance to the beginner in radiology are some thoughtful and well put observations on the form and content of the radiological report. Throughout, the author stresses the rational approach to the roentgen study, with thoroughness, observation, and reasoning the three pillars on which a satisfactory study rests.

All who are interested in radiology will find some phase of this book of interest but it will be of greatest value as a primer for the physician who has limited experience with roentgen rays and who wants a broad general view rather than a textbook or reference volume.

E. F. Lang M.D.

The Abnormal Pneumoencephalogram. By Leo M. Davidoff, M.D., Director of Neurological Surgery, Beth Israel Hospital, New York City; Clinical Professor of Neurosurgery, New York University—Postgraduate Medical School; and Bernard S. Epstein, M.D., Associate Radiologist, The Jewish Hospital of Brooklyn, Brooklyn, N. Y., and Instructor in Clinical Radiology, Long Island College of Medicine. Cloth. Price, $15.00. Pp. 506, with 289 illustrations. Lea & Febiger, Washington Square, Philadelphia 6, Pennsylvania, 1950.

Those who are familiar with the excellent volume concerning "The Normal Encephalogram" by Davidoff and Dyke will find in this work a logical excursion into the field of intracranial abnormalities with the same lucid style of writing and the clear and logical presentation of factual material which characterizes the earlier work. One feels that he is being treated to a personally conducted tour of the author's very extensive and widely representative museum of intracranial abnormalities. Subdivision by subdivision the subject material is treated with great uniformity including introductory comments, a highly condensed and carefully prepared abstract of pertinent literature, and then detailed presentation of the material from the authors' experience. The publishers have done an excellent job of book making and are to be complimented in particular upon the fine quality of the reproduced roentgenograms.

The book serves extremely well as a factual text and as an atlas on the subject. It makes a splendid companion piece to the Davidoff and Dyke "Normal Encephalogram" which it is intended to be. For those who are engaged in any phase of intracranial diagnosis this book will hold a place of honor and great utility.

Fred J. Hodges, M.D.

Post-Graduate Lectures on Orthopedic Diagnosis and Indications. By Arthur Steindler, M.D., F.A.C.S., Professor of Orthopedic Surgery, State University of Iowa, Iowa City, Iowa. Volume III. Section A: Tuberculosis of the Skeletal System. Section B: Osteomyelitis. Cloth. Price, $8.75. Pp. 284, with 255 illustrations. Charles C Thomas, Publisher, 301 East Lawrence Avenue, Springfield, Illinois, 1952.

The volume described is the third in a series of four. It consists of lectures as delivered by the author to his post-graduate students of orthopedic surgery. In it are duplicated the format and method of presentation used in the first two volumes.

The subjects discussed are tuberculosis of the skeletal system and osteomyelitis. Section A is subdivided into six lectures. The pathogenesis, pathology, clinical and laboratory phases, clinical course, general and specific treatment plans are reviewed in general and individually for tuberculosis of the spine and lesions of upper and lower extremities. Section B is subdivided into five lectures. Osteomyelitis is discussed in a similar fashion in all its phases, with the approach to the differential diagnosis stressed.

The author follows his original method of presentation. Other clinicians, as mature, might approach both problems differently. However, the purpose of these volumes has been declared and a master teacher has again presented material in a clearly delineated and logically arranged fashion which is designed to appeal to the post-graduate student primarily. It is believed the space allotted to the place of the antibiotics and chemotherapeutic agents in a treatment plan has been minimized.

The volume is adequately illustrated. The size, type and paper pleasantly duplicate the first two volumes.

Frank P. Walsh, M.D.

Cancer of the Colon and Rectum. Its Diagnosis and Treatment. By Fred W. Rankin, B.A., M.A., M.D., LL.D., Sc.D., F.A.C.S., Surgeon, St. Joseph's and Good Samaritan Hospitals, Lexington, Kentucky; Clinical Professor of Surgery, University of Louisville, Louisville, Kentucky; and A. Stephens Graham, M.D., M.S. (in Surgery), F.A.C.S., Surgeon, Stuart Circle Hospital, Richmond, Virginia; Associate Professor of Surgery, Medical College of Virginia, Second edition. Cloth. Price, $7.50. Pp. 427, with 148 illustrations. Charles C Thomas, Publisher, 301 East Lawrence Avenue, Springfield, Illinois, 1950.

Recognized as the finest single reference on the subject of cancer of the colon and rectum since its first publication in 1939, the second edition of this monograph has attained increased stature and value because of the consolidation of additive experience not only on the part of the authors in the management of this disease but also from large clinics and hospital centers, both in this country and abroad, who have had a primary interest in cancer of the large intestine.

Written in three parts, Part I is a thoroughly detailed discussion of the anatomy, physiology, incidence, pathology and diagnosis of malignant disease of the colon and rectum. Part II provides an excellent consideration of prognosis, operability, choice of operation, preoperative and postoperative care and operative mortality and end results.

Experiences accumulated from medical centers particularly interested in this subject provide an excellent consideration of choice of operation, operative mortality and end results in carefully followed large series of cases.

A chapter written by Dr. Fred M. Hodges on radiotherapy of carcinoma of the rectum provides a thoughtful and concise review of the value of deep roentgen therapy and radium in the treatment of this disease. Although it is hoped that improvement of radiotherapy techniques will provide a betterment of results obtained by such therapy, surgery remains the treatment of choice in resectable lesions in good risk patients. Good palliation has been obtained in certain inoperable or recurrent cases by deep roentgen therapy. Each case, however, must be individualized. Routine postoperative roentgen or radium therapy in rectal carcinomas with lymph node involvement has not been recommended.

Part III discusses with thoroughness the various technical aspects of definitive and palliative operation.

This book is well and clearly written. The 148 illustrations are of excellent quality. It contains all the essential knowledge of this subject to date and should be of great value to all who are interested in this field.

Frederick A. Coller, M.D.

Über die röntgenologischen Darstellungsmöglichkeiten des weiblichen Genitalapparates mit Hilfe von Jodöl und Jodsol. Von Dozent Dr. med. habil. J. Erbslöh, Bad Oldesloe. Paper. Price, DM 16.80. Pp. 74, with 64 illustrations. Georg Thieme, Diemershaldenstrasse 47, Stuttgart, Germany, 1951.

This monograph is for the most part a dissertation on the various physicochemical properties of the many contrast media used in the roentgen examination of the female genital tract. In this respect, it is a very complete and comprehensive treatise, regardless of what one may think of some of the clinical applications discussed in the third part of the book.

The author points out that the many preparations used vary according to viscosity, surface tension and wetting ability. These properties affect the end result in the roentgenogram. The fundamental changes of the physicochemical qualities when the iodized oils are transformed into colloidal solutions are carefully measured and documented. This particular phase is fundamental and of great value.

Conclusions are drawn on the clinical results as follows:

1. Water soluble preparations containing iodine irritate the mucous and serous membranes because they are hypertonic solutions. They are thus not favorable for general use because of this, even though their physical qualities are better. 2. Preparations which are soluble in oil are generally more compatible, although when used intrauterinely and to visualize the genital tract generally, they have the disadvantage of having too high a viscosity, if undiluted and when diluted are very poor wetting agents. 3. The various pharmacological and physicochemical properties which render an opaque material ideal for purposes of contrast are best reached when the iodized oil is

transformed into a colloid solution. This best meets the requirement for roentgenography for ideal conditions of viscosity, surface tension and wetting ability.

A third part of the monograph deals with the clinical investigations in which the author shows the importance of getting the proper spread of the opaque material over the surface of the fetal body in utero if a good fetalogram is to be obtained.

The reviewer is a little concerned over this particular procedure. It was attempted in America some years ago and discontinued because of possible dangers to the fetus. The roentgenograms are excellent, but one wonders just how much harm might result. However, the author has found the ideal opaque medium to use when one wishes to do this and also to do efficient uterosalpingography.

PAUL C. SWENSON, M.D.

GRUNDLAGEN DER THERAPEUTISCHEN STRAHLENWIRKUNG. Von Dr. Hermann Holthusen. Paper. Pp. 34. Conrad Kloss, Bergstrasse 26, Hamburg 1, Germany, 1951.

In this booklet is presented one of the University lectures in Hamburg, Germany. Holthusen discusses in a philosophical manner some of the basic problems in therapeutic radiology, a field which might well be labeled "biophysica." He deals with the effects of ionizing radiation on cells and tissues, and analyzes the target theory, first developed by Dessauer, and its relationship to the research of Mueller on chromosome mutations. The roles of thymonucleic acid, water and oxygen content of cells as it affects radiosensitivity are discussed. Some space is allotted also to the problem of wavelength dependence of the biologic effect. While the nature of the presentation did not allow the author to go into great detail, his lecture is recommended to radiologists with a good reading knowledge of the German language.

E. A. POHLE, M.D.

BOOKS RECEIVED

THE SCALP IN HEALTH AND DISEASE. By Howard T. Behrman, A.B., M.D., Assistant Clinical Professor of Dermatology, New York University Post-Graduate Medical School, etc. Cloth. Price, $12.75. Pp. 566, with 312 illustrations. C. V. Mosby Company, 3207 Washington Boulevard, St. Louis 3, Missouri, 1952.

VISUAL ANATOMY: THORAX AND ABDOMEN. By Sydney M. Friedman, M.D., Ph.D., Professor of Anatomy, University of British Columbia, Vancouver, Canada; Formerly, Associate Professor of Anatomy, McGill University, Montreal, Canada. Cloth. Price, $10.50. Pp. 203, with 91 illustrations. Charles C Thomas, Publisher, 301 East Lawrence Avenue, Springfield, Illinois, 1952.

DISEASES OF THE CHEST. By T. Royle Dawber, A.B., M.D., F.A.C.P., Senior Surgeon, U.S.P.H.S.; Chief of Heart Disease Epidemiology Study, National Heart Institute; Assistant in Medicine, Harvard Medical School; and Lloyd E. Hawes, A.B., M.D., D.A.B.R., Radiologist at Faulkner Hospital; Consultant at U.S.P.H.S. Hospital, Boston. Cloth. Price, $10.00. Pp. 440, with 216 illustrations. Williams & Wilkins Company, Mount Royal and Guilford Avenues, Baltimore 2, Maryland, 1952.

GASTROINTESTINAL X-RAY DIAGNOSIS. By Max Ritvo, M.D., Assistant Professor of Radiology, Harvard Medical School; etc.; and I. A. Shauffer, M.D., Instructor in Radiology, Harvard Medical School, etc. Cloth. Price, $20.00. Pp. 838, with 470 illustrations. Lea & Febiger, Washington Square, Philadelphia 6, Pennsylvania, 1952.

ROENTGENOLOGY IN OBSTETRICS AND GYNECOLOGY. By William Snow, M.D., Chief Radiologist, Veterans Hospital; Consulting Radiologist, Willis-Knighton Memorial Hospital and Clinic, Shreveport, Louisiana; Formerly Director of Roentgenology, The Harlem Hospital, The Bronx Hospital, New York, New York. Cloth. Price, $10.50. Pp. 363, with 273 illustrations. Charles C Thomas, Publisher, 301 East Lawrence Avenue, Springfield, Illinois, 1952.

RARE MANIFESTATIONS OF METABOLIC BONE DISEASE. Their Practical Importance. By I. Snapper, M.D., Ph.D., Physician and Director of Medical Education, Mt. Sinai Hospital; Clinical Professor of Medicine, Columbia University College of Physicians and Surgeons, New York City. Fabrikoid. Price, $3.00. Pp. 96, with 18 illustrations. Charles C Thomas, Publisher, 301 East Lawrence Avenue, Springfield, Illinois, 1952.

TRATTATO DI STRATIGRAFIA. By Prof. A. Vallebona. Cloth. Pp. 347, with 290 illustrations. Casa Editrice Dottor Francesco Vallardi, Milan, Italy, 1952.

INJURY OF THE XIPHOID. By Michael Burman and Samuel E. Sinberg. Cloth. Price, $3.50. Pp. 92, with 12 illustrations. Columbia University Press, 2960 Broadway, New York 27, New York, 1952.

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ABSTRACTS OF RADIOLOGICAL LITERATURE

Department Editor: T. Leucutia, M.D., Harper Hospital, Detroit 1, Michigan

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ROENTGEN DIAGNOSIS

Abdomen

Casal, Manuel A., and D'Alotto, Victorino. Estenosis crónica del intestino grueso. (Chronic stenosis of the large intestine.) *Prensa méd. argent.*, March 28, 1952, *39*, 583–594.

Intestinal obstruction is an acute phenomenon, and may occur in an intestine which had been relatively normal up to the time of the episode, or in one which has gradually been involved by a stenosing lesion, intestinal or extra-intestinal. Fortunately, the latter type of lesion may cause intermittent or incomplete obstruction.

Stenotic processes residing in the wall of the colon may be congenital, inflammatory, traumatic, postoperative, vascular, neoplastic or may be due to irradiation. Malignant tumors form the most frequent cause. Sites of election include the rectum, sigmoid colon and cecum. About two-thirds are in the left colon.

Tuberculosis, hyperplastic or ulcerative, may be stenosing and occurs in the ileocecal region, the cecum or ascending colon.

Stenotic lesions in the hepatic flexure are unusual; a case is presented which was caused by congenital peritoneal bands. Pericholecystitis may involve the region of the hepatic flexure and right side of the transverse colon. Epiplopericolitis has been indicted in the region by Rienzo. Cholecystocolic fistula is occasionally found.

Regional enteritis of Crohn may involve the ileocecal region or may cause localized segments of colitis. Sigmoid inflammation may be present without diverticulitis, but the latter is usually present.

Amebiasis is frequently in the cecum but may involve other portions of the colon, and even the rectum. Ulcerative colitis may be of segmental distribution. Lymphopathia venereum causes rectal stenosis.

The importance of proper diagnosis lies in establishing the best mode of therapy.—*Charles M. Nice, M.D.*

Schneider, Henry C. Adenomatous polyps of the large intestine. *Rev. brasil de gastroenterol.*, March–April, 1952, *4*, 315–320.

The author gives a brief review of the literature with discussion of adenomatous polyps of the large intestine.

He reports 85 cases having one or more polyps in a series of 2,000 private patients examined with the aid of a sigmoidoscope. The lesions were fulgurated or excised. There were 13 cases with recurrence following fulguration and 2 through transcolonic approach. The author stresses the need for careful follow-up on each case, since there is a close relationship between adenomatous polyps and cancer of the colon.—*Vernon L. Peterson, M.D.*

Genitourinary System

Berg, Owen C., and Allen, David H. Use of carbonated beverage as an aid in pediatric excretory urography. *J. Urol.*, March, 1952, *67*, 393–396.

The method described in this paper is a variation of the procedure recommended by Matthei in which the young patient is fed an amount of formula or milk in an effort to distend the stomach and to displace the shadow of gas in the colon and small intestine.

The authors have modified this method by using a carbonated beverage which overdistends the stomach with carbon dioxide gas in addition to the swallowed air. Roentgenograms are made in the supine position at intervals of 5, 10, 15, and 30 minutes. One of the advantages of this method is that the carbonated beverage can be administered at any convenient time during the examination. The soft tissue detail of the renal parenchymal shadows and of the upper portion of the iliopsoas shadows is considerably improved by this procedure. —*George W. Chamberlin, M.D.*

Astley, Roy. The use of hyaluronidase in paediatric urography. *J. Faculty of Radiologists*, April, 1952, *3*, 286–289.

Astley describes a technique for subcutaneous urography in infants and in young children. He cites the objections and difficulties in connection with intravenous and intramuscular use of a contrast medium. Intravenous injection may involve surgical dissection to locate a vein and occasionally a vein is sacrificed that may be needed later for intravenous therapy. The time between injection intramuscularly and obtaining sufficient renal concentration for good roentgenograms is considerably longer than by the intravenous route. Moreover, the contrast medium may produce a painful lump in the muscles lasting for an hour or more. In a wasted infant it may be difficult to find enough muscle in which to make the injection even in small divided doses.

The main therapeutic application of hyaluronidase, an enzyme which reduces the viscosity of hyaluronic acid, is to increase the rate of absorption of subcutaneously administered fluid. After preliminary investigation the following technique was adopted: Irrespective of size (for ages between a few weeks to five years) 10 cc. of 35 per cent diodone is used. This is diluted to 30 cc. with sterile distilled water in which one ampule (1,000 units) of hyaluronidase has been dissolved. Hyaluronidase solution must be prepared freshly, immediately before use. It dissolves readily if a little of the sterile water or diluted diodone is syringed several times in and out of the ampule. The injection is made entirely subcutaneously, in two

doses of 15 cc. each, over the scapulae. By turning the needle the solution is spread around the site of injection and immediately afterwards massage is applied to aid spread and absorption. The only pain appears to be that of the needle prick. The lump produced is soft and disappears in a matter of minutes, in contrast to the hard mass of comparatively long duration that undiluted diodone, even in quantities as small as 3 cc., will produce when given intramuscularly to a wasted infant. The author states further that usually diodone is visible in the renal pelves in less than five minutes. The best roentgenograms are obtained between fifteen and forty-five minutes, times which compare very well with intravenous injections and which are considerably shorter than with intramuscular use. He believes the concentration shown on the roentgenograms is equal to that with intravenous injection.—*Samuel G. Henderson, M.D.*

Fitzgerald, W. L., and Thomas, M. D., Jr. Interesting bone changes in plain urograms. *J. Urol.*, April, 1952, *67*, 547–556.

After a brief discussion of bone metabolism and the significance of calcium, phosphorus, and phosphatase associated with bone diseases, the authors discuss six different bone lesions with an analysis of the clinical and pathological findings.

In senile osteoporosis, the generalized demineralization is not accompanied by any changes in the calcium, phosphorus or phosphatase chemistry.

Patients with hyperparathyroidism show localized cystic bone changes with or without renal calcinosis. The serum calcium is high and the phospohrus low and there is increased calcium excretion. The alkaline phosphatase is increased in 100 per cent of the cases which show bone changes.

Paget's disease of bone is characterized by osteolytic and osteoblastic activity. Some areas of bone are very dense whereas other areas are fibrocystic in nature. The alkaline phosphatase is high where the bone lesions are extensive but may be only slightly elevated in the earlier cases. The acid phosphatase is normal and there is normal calcium and phosphorus in the serum.

The typical bone lesions of multiple myeloma appear as sharply circumscribed radiolucent areas commonly involving the ribs, spine, pelvis, and skull. The blood calcium may be normal or elevated. The globulin fraction of the blood protein is elevated and there is a reversal of the albumin-globulin ratio. The urine shows Bence-Jones protein in over half of the cases. Bone marrow biopsy reveals myeloma cells.

In metastatic carcinoma from the thyroid, breast, kidney, or lung, the blood calcium and phosphorus studies are normal. The alkaline phosphatase may be somewhat elevated where the bone lesions are of the osteoblastic type. The acid phosphatase and the serum phosphorus are normal. In contrast to most other metastatic bone lesions, particularly those occurring in the male, metastatic carcinoma from primary carcinoma of the prostate is predominantly osteoblastic but may be of the mixed type, whereas the osteolytic type is uncommon. Usually the pelvis, spine and ribs are involved in that order. The serum acid phosphatase, is increased in 85 per cent of patients who show bone metastasis from primary prostatic carcinoma. The alkaline phosphatase is also increased in proportion to the amount of osteoblastic activity.

A condensed table of the pertinent data of all of these diseases is presented in the article.—*George W. Chamberlin, M.D.*

Emmett, John L., Alvarez-Ierena, J. Jose, and McDonald, John R. Atrophic pyelonephritis versus congenital renal hypoplasia. *J.A.M.A.*, April 26, 1952, *148*, 1470–1477.

This is an attempt to clarify the two descriptive terms of "chronic atrophic pyelonephritis" and "congenital hypoplasia" of the kidneys. Contrary to general opinion, the authors' impression is that it is usually difficult, if not impossible, to distinguish these two entities, if in reality two such separate entities actually exist.

The material studied consisted of 400 cases in which urograms indicated a definite reduction in size of the kidney. In order to limit the study further, all cases were excluded in which the cause of the "atrophy" was apparent, or in which associated pathological conditions existed. Thus, they eliminated cases of obstructive uropathy with associated pyelectasis, which, as is well known, leads to renal atrophy. Also eliminated from the study were cases with associated renal or ureteral calculi, cyst, and tumor, as were patients with known "medical" diseases, such as glomerulonephritis and nephrosclerosis (usually bilateral, which would remove them automatically from this study). Finally eliminated were those patients who had had a bilateral sympathectomy, but the patients with unilateral sympathectomy were not excluded. This left a total of 183 cases; in 79 nephrectomy had been performed and thus gross and microscopic findings in these cases were available for detailed study.

The authors come to the conclusion that unilateral "hypoplastic" or "atrophic" kidney represents several different and distinct pathological entities. They feel certain that in some of the cases the lesion is congenital, while in others it is the result of acquired or of a combination of congenital and acquired lesions. One of the commonest acquired lesions is infection ("chronic atrophic pyelonephritis"). In some cases of apparent chronic "atrophic" pyelonephritis the kidney may have been congenitally small to start with, but there is no method to accurately decide this problem.

This study indicates that it is impractical and almost impossible to attempt to distinguish these conditions—clinically, pathologically, or urographically—with any degree of accuracy.—*E. A. Addington, M.D.*

Skeletal System

Miller, Charles W. The temporomandibular joint. *J. Am. Dent. A.*, April, 1952, *44*, 386–393.

Diseases of the temporomandibular joint are classified into three groups: (1) those caused by systemic disturbances; (2) those caused by malocclusion or absence of teeth; (3) those caused by external trauma and dislocation. Included in the first group is rheumatoid arthritis of the temporomandibular joint which occurs in about 50 per cent of the patients with this disease. Hyperplasia of the condylar head is present in osteochondroma, acromegaly, Paget's disease and osteoid arthritis. The second group comprises premature contact between the cusps of malpositioned teeth causing the teeth to occlude in other than centric position which displaces the head of the condyle. Painful and noisy symptoms accompany this abnormality. Absence of the posterior teeth allowing the condyles to traumatize the articular disks may lead to auditory disturbances, neuralgias or a deforming arthritis of traumatic origin. In the third group, the most important considerations are dislocations and fractures of the neck of the condyle. Splinting by wiring is the treatment of choice. Hypermobility of the temporomandibular joint is treated by the injection of sclerosing agents into the joint cavity.

Removal of the condylar head is possible without lasting deformity or malfunction.

Roentgenograms of the joint are considered to be of doubtful value because of the structure and anatomic position of the joint. Laminagrams show the anatomic relationship well but differentiation is lacking.

An excellent discussion of the anatomy and movement at the temporomandibular joint is included.—*Lawrence A. Pilla, M.D.*

Greve, Wilhelm. Spontanfrakturen nach Röntgentiefenbestrahlung. (Spontaneous fractures after deep roentgen irradiation.) *Strahlentherapie*, 1952, *86*, 617–621.

Three cases of spontaneous costal fractures developed after intensive postoperative irradiation for treatment of carcinoma of the breast. No callus formation could be demonstrated several years after the irradiation; in fact, the fracture lines increased in width up to 3 cm. Simultaneously fibrosis appeared in the corresponding lung fields. The fractures and the failure of healing are attributed to having exceeded the tolerance dose of bone (3,800–4,200 r) considerably.

An additional case of spontaneous fractures of the femoral necks after irradiation of inguinal lymph nodes in the treatment of carcinoma of the penis is reported. The depth dose at the femoral necks was approximately 1,500 r, much less than the tolerance dose of bone. The patient's senility and the accompanying atrophy of bone are incriminated in this instance.—*Henry G. Moehring, M.D.*

Klein, A. Zur Frage der Erblichkeit der Marmorknochenkrankheit. (The question of heredity in marble bones.) *Fortschr. a. d. Geb. d. Röntgenstrahlen ver. m. Röntgenpraxis*, March, 1952, *76*, 366–371.

The author examined 14 out of 16 members of the family of a patient affected with marble bones. Four male members showed positive findings. Three of these were of the first generation and 1 a grandchild. Two males of the first generation and all 8 examined females had no pathological findings. The distribution of the disease only in the male members and the skipping of one generation to reappear in the following generation suggests a sex-limited inheritance.

The author notes the analogy of the hereditary character of marble bones with that of hemophilia and red-green blindness. He explains the hereditary character of marble bones as follows: If one supposes that predisposition to the disease lays in the x chromosome, a sick man with xy chromosomes and a healthy woman with xx chromosomes beget exclusively healthy sons. In this instance, the x chromosome originates from the healthy mother while the father contributes the y chromosome having no predisposition to the disease. On the other hand, all daughters are predisposition carriers having one of the x chromosomes from the sick father. They themselves do not manifest the disease because of the restraining x chromosome from the healthy mother. They are therefore called conductors as they transmit the disease to half their sons, the y chromosome having no restraining properties. Likewise, half of their daughters are also conductors.

The author is aware of the occurrence of marble bones in females and thinks that it may be due to two different types of heredity: the chromosome sex-limited heredity and an irregular dominant heredity. Why the disease is inherited once through this pattern and once through the other is beyond the author's knowledge.

The introduction to this paper is an extensive review of the literature concerning the etiology of marble bones.—*Salomon Silvera, M.D.*

Graham, Jacob J. Solitary unicameral bone cyst; a follow-up study of thirty-one cases with proven pathological diagnoses. *Bull. Hosp. Joint Dis.*, April, 1952, *13*, 106–130.

Solitary unicameral bone cyst is a relatively rare lesion. The author reports a follow-up study of 31 of a total of 56 cases treated during the past twenty-five years.

Jaffe and Lichtenstein define solitary unicameral bone cyst as "a fairly large fluid-filled unicameral cavity, located in the interior of the affected bone shaft and delimited by a more or less thinned and ex-

panded cortex, the inner surface of which (roughened and sometimes distinctly ridged) is lined by a rather thin membrane of connective tissue from which little material as a rule can be curetted away." The great majority occur in the proximal portions of the humerus and femur, but other locations such as the os calcis and small tubular bones have been described. The lesion is generally reported as affecting the younger age groups, about childhood and adolescence, and males are reported as predominating over females.

The roentgen appearance is generally a typical one when site of predilection and age are considered, but when present elsewhere, the unicameral bone cyst may be confused with other lesions. The cyst is seen abutting on or near the epiphyseal plate. It presents a rarefied lesion with an overlying expansion and attenuation of the cortex, and evidence of irregular trabeculation here and there within the cyst. These trabeculae represent ridges on the medullary surface of the cortex rather than actual septa dividing the cyst; hence the name *unicameral*, meaning one compartment.

The pathology is characteristic. Grossly, the overlying cortical wall is often paper thin or deficient in places and the cyst presents a blue sheen due to underlying fluid shining through. The cyst fluid is either clear or yellow and may be serosanguineous; at times no fluid may be found in the cavity. Microscopically, the lining membrane is quite thin and consists of only one or two layers of connective tissue cells. Hemosiderin crystals, lipoid, cholesterol crystals, and osseous trabeculae may be seen within the membrane, and osteoclasts, foreign-body giant cells, and phagocytes may be seen scattered here and there through the lesion.

Clinically, the condition is most often noted as a consequence of pathologic fracture. However, limp and pain may be other signs and symptoms which first call attention to its presence.

Thirty-one cases of unicameral cysts were followed clinically and roentgenographically for periods ranging from one to fourteen years.

A 41.9 per cent recurrence was noted. An analysis of the different methods of treatment shows a high recurrence rate in curettage of the cyst wall plus insertion of bone chips (60 per cent). The number of cases involved in the other types of treatment is too small to permit drawing any final conclusion. However, it does appear that chemical cauterization of the cyst wall possesses some advantages.—*C. Peter Truog, M.D.*

Maylahn, Donald J. Thorn-induced "tumors" of bone. *J. Bone & Joint Surg.*, April, 1952, *34-A*, 386–388.

Organic material, such as the thorns of plants, when present in or near a bone, can produce a pathological reaction, the roentgenographic appearance of which may resemble bone tumor. This possibility should be considered in the differential diagnosis of bone neoplasms.

The author reports 3 cases in which thorns of a yucca, a rose and a date palm were removed from the hands of the patients. In one the roentgenogram showed cortical erosion of the bases of the fourth and fifth metacarpals; in the second, an osteolytic lesion in the distal end of the first metacarpal, and in the third, "onion peel" thickening of the cortex and periosteum in the middle third of the shaft of the fibula. It is not known whether other organic material will cause a similar reaction.—*Ralph S. Bromer, M.D.*

Stewart, Marcus J., and Richardson, T. R. Giant cell tumor of bone. *J. Bone & Joint Surg.*, April, 1952, *34-A*, 372–386.

This paper is based on a study of 41 cases of giant cell tumor observed over a period of twenty years. The average age in the series was 28.4 years. The clinical features, the roentgenographic appearance, the gross pathology and the microscopic appearance of giant cell tumor are discussed. The authors' attitude toward giant cell tumor variants is patterned after that of Jaffe and his associates. They believe that there is only one specific entity which can be called a giant cell tumor. Each variant is either a giant cell tumor modified by treatment or an entirely separate and different entity. Thus a spindle cell variant on close examination may be a medullary fibroma. Similarly the cartilaginous variant may be a chondroblastoma. The epulis, brown tumors of hyperparathyroidism, and tendon sheath xanthomas are considered entirely different lesions. However, the authors state that they agree with Geschickter and Copeland that there is a close kinship between giant cell tumor and solitary bone cysts, and that they probably have a common origin.

In their conclusions, the authors state that true giant cell tumors are quite rare. Solitary bone cysts occur with about the same degree of frequency, while sarcomas of bone are found five times as often as either. Giant cell tumors are neoplasms and as such can be expected to recur in sites of incomplete extirpation. Moreover, they may undergo malignant changes, either through trauma or as a result of inadequate treatment. The number and size of the giant cells, together with the number of nuclei per cell, furnish the best criterion for determining the prognosis. The small, sparsely nucleated giant cells with a tendency for collection of many cells in each high power field indicate more activity and rapid growth. These tumors have a greater tendency to recur or become malignant.

Roentgen irradiation is recommended only for those lesions inaccessible to surgery. The danger of incomplete cures, recurrence, and an overdosage of roentgen rays are not as important in the authors' opinion as the hazard of late sarcomatous changes. Resection of the involved portion of a bone where

feasible is the treatment of choice. The distal portion of the radius can be supplanted successfully by the proximal end of the fibula. The femoral condyle can be replaced by a section from the ilium. If resection is not practical, the next best method of treatment which is recommended is thorough curettage, with or without cauterization, together with multiple bone grafts or chips to fill the cavity. The most important single factor in this method applies to the treatment of solitary bone cyst as well as giant cell tumor. This factor is thorough curettage, breaking through and destroying the limiting wall, thus opening into normal cancellous bone of the shaft. Bone chips or grafts should be inserted when large defects are created.

A few of the cases of the series were graded by the authors according to the criteria suggested by Jaffe and his co-workers. They believe this grading may be of questionable value in predicting the likelihood of recurrence, but it is useful in that Grade II and Grade III give the pathologist convenient categories by which he may indicate the degree of his suspicion in regard to the malignant possibilities of the tumor.—*Ralph S. Bromer, M.D.*

Møller-Christensen, Vilh., and Faber, Børge. Leprous changes in a material of mediaeval skeletons from the St. George's Court, Naestved. *Acta radiol.*, March–April, 1952, *37*, 308–317.

Leprosy may be traced as far back as ancient civilization. It is one of the oldest and most severe scourges that ever afflicted humanity. Among the old civilized nations of the east and in medieval society, leprosy was regarded as a dangerous and incurable infectious disease and lepers were therefore treated as outcasts, excluded from the company of their friends and family and banished to spend their lives in deserts or uninhabited waste places. Some lepers were interned in St. George's Courts. The present material is derived from such a reservation—the St. George's Court in Aaderup near Naestved. The first account of this reservation dates back to 1261. It fell into disuse in 1542 as did the other leper courts in Denmark. During the 300 years of their existence their mission was so well fulfilled that leprosy in Denmark was virtually exterminated.

The authors' studies of these ancient skeletons show that the skeletal changes affecting the hands and feet do not differ in the medieval material from the changes described in contemporary lepers. However, cranial changes were found which have not been described previously. The term "facies leprosa" has been coined to describe the appearance of these skeletons in which there was total atrophy of the anterior nasal spine and disappearance of the external compact layers and also of the projecting parts of the facial bones on a level with the lower half of the nasal aperture of the skull. This gives the nasal aperture a peculiar appearance: its breadth is increased and the numerous exposed diploic cavities and vascular channels lend the bony surface the appearance of coarse pumice stone (as if it had been treated with sandpaper).

In addition, there is a characteristic atrophy of the alveolus around the four upper incisors spreading from the midline leading to exposure of the roots so that, in advanced cases, these teeth are lost or become loose in the gingiva.

Since these cranial changes have been found only in association with typical leprous changes of the hands and feet and have not been described in other diseases, it seems justifiable to assume that "facies leprosa" is diagnostic of leprosy.

To summarize, these studies of skeletons show that the osseous changes found in leprosy 400 to 700 years ago were identical with those occurring today. Moreover, there are changes produced by leprosy which were previously unrecognized and which are easily demonstrable by roentgen examination of the skull. This fact may prove of clinical significance in doubtful cases of leprosy.—*Mary Frances Vastine, M.D.*

Mosekilde, Eyvind. "Stippled epiphyses" in the newborn and in infants. (Synonyms: chondrodystrophia calcificans congenita, dysplasia epiphysialis punctata.) *Acta radiol.*, March–April, 1952, *37*, 291–307.

On the basis of 39 cases from the literature and 3 of the author's cases of stippled epiphyses in the newborn and in infants, a description of the clinical and roentgenologic picture of this condition is presented. Five signs are emphasized:

1. Micromelia and rhizomelia. In the majority of these cases there is more or less pronounced shortening of the extremities due to a decrease in the length of the humeri and femora. The peripheral bones are usually of normal length. Some of the cases are dwarfs because of the short lower extremities. In milder cases the micromelia and rhizomelia are not so pronounced and normally proportioned extremities may be found in some instances.

2. Shortening of only one or two extremities. If this is present, *i.e.*, if only one or two bones are involved, the average decrease in length is 1 to 4 cm.

3. Semiflexion and limitation of extension of the larger joints.

4. Bilateral congenital cataracts were present in 9 out of 42 patients.

5. Stippled epiphyses. The densities in these epiphyses may be of various types: (1) single, scattered well-defined rather regular densities simulating ossification centers; (2) numerous larger or smaller, often highly irregular densities, occupying the greater part of the epiphysis, possibly surrounding a central ossiffication center; (3) cloudy densities occupying more or less of the cartilage.

The differential diagnosis does not present any difficulties. The clinical picture is usually characteristic. The presence of shortening in one or two extremities, contractures and cataracts give the diagnosis. The roentgen changes in the epiphyses are so characteristic as regards time of occurrence (before three or four years of age at which time the stippling disappears) and appearance that they cannot be mistaken for signs of other diseases.—*Mary Frances Vastine, M.D.*

Bosworth, David M., and Wright, Howard A. Streptomycin in bone and joint tuberculosis. *J. Bone & Joint Surg.*, April, 1952, *34-A*, 255–266.

Four problems are considered in this study on the use of streptomycin in bone and joint tuberculosis: (1) Will streptomycin alone (that is without surgery) check or heal closed lesions? (2) Should sinuses be drained? Should they be closed or left open thereafter? (3) Where sinuses are present what permanency of closure results with the use of streptomycin? (4) Does the prolonged use of streptomycin give disastrous results either from toxicity of the drug or from development of resistance in the organisms? The effect of streptomycin, 1 gram daily, with and without the use of para-aminosalicylic acid, 10 grams daily, in the course of treating 118 tuberculous lesions of bone and joints, is assessed in this paper.

The authors found that, despite the use of streptomycin, most patients with closed lesions, whose findings were consistent with a diagnosis of tuberculosis, eventually came to stabilizing operations or other surgery, if followed long enough, either because of activity of the disease or because of bone or joint destruction already present.

In regard to the second problem, incisional surgery to drain abscess material about weight-bearing joints under the protection of streptomycin may temporarily (for a few months) give the impression of control of the situation without definitive surgery. However, a long-range view based upon experience with large numbers of tuberculous patients who have been unable to escape surgery is necessary for an accurate clinical evaluation. Even though an abscess in a spine lesion is drained or incised and closed, progression of the destructive process, the angulation, and the disability still demand surgical fixation.

Of 86 patients whom the authors were able to follow, 74 had their sinuses healed since they closed under streptomycin therapy.

In 5 patients, deafness occurred. Vertigo and ringing in the ears, also headache, are other complications. A transitory dermatitis developed in 1 patient which disappeared with continuance of the drug at a lower dosage. The authors conclude that complications arising from the use of streptomycin are fairly innocuous and thoroughly acceptable, in view of the disasters which occur without its employment. —*Ralph S. Bromer, M.D.*

Evans, Edward T. Tuberculosis of the bones and joints; with special reference to the influence of streptomycin and the application of radical surgical techniques to certain effects and complications of the tuberculous lesion. *J. Bone & Joint Surg.*, April, 1952, *34-A*, 267–278.

The author's experience, he states, is a plea for re-evaluation of the treatment of bone and joint tuberculosis. His study would seem to disprove four well established dicta in regard to the treatment:

I. The surgical attack on tuberculosis, even though the disease is progressively destructive locally, must await the stabilization of the infection as a whole as evidenced by a favorable response to rest, subsidence of the systemic reaction and stability of the sedimentation rate.

II. In disseminated tuberculosis which is manifest in multiple lesions that are gross in nature, surgical measures are contraindicated until the disease seems stabilized.

III. The presence of abscess at the site contemplated for surgery is a contraindication to arthrodesis or other procedures, and especially the use of bone grafts.

IV. The development of serious abscesses and sinuses, either spontaneous or postoperative, represents a complication which is often insurmountable and may doom the patient to gradual decline and death from an amyloidosis.

In regard to the first, Evans states that if one recognizes that tuberculosis is a systemic disease requiring a sanatorium regimen and the combined efforts and teamwork of a well trained staff for its best control, one will still disagree with this dictum in view of the newer concepts of treatment. In regard to the second, early arrest or eradication of a lesion should and will improve the patient's general status. Miliary spread was justly feared in the past but today, with antibiotics, its occurrence is minimized. In regard to the third, excision of an abscess, either as a preliminary step or at the time of arthrodesis or of excision, will be eminently successful. Judicious extirpation of the abscess, administration of antibiotics and adequate fixation or excision overcome the complications in a high percentage of cases. In regard to the last dictum, Evans states that this view has been tempered by the adjunct use of streptomycin but, he fears, with an all too frequent disregard of the possibilities of established surgical procedures.

Cases are presented in the paper which illustrate the managemant of the more severe complications by adequate extirpation, debridement, and early closure; the principles are the same as those now applied to war wounds and compound fractures. Two hundred and thirty-eight cases were reviewed. Of these, 42 were not treated with streptomycin and were included for control purposes. Ten to 15

per cent of the cases showed regression of various degrees during the administration of the drug. Without streptomycin, improvement occurred slowly under a well controlled sanatorium regimen and was increased only moderately by adjunct operative intervention. Streptomycin initiated an early improvement but such improvement may not always be maintained and surgery is an effective method of treatment directed toward stabilization of the process. The combined use of surgery and streptomycin gave best results, while a sanatorium regimen alone was most disappointing. Since the advent of the drug, combined with judicious surgery, the author believes that he has been able to reverse the four dicta he mentions in his paper. To illustrate this, short case histories of 17 patients are included.—*Ralph S. Bromer, M.D.*

Harris, R. I., Coulthard, H. S., and Dewar, F. P. Streptomycin in the treatment of bone and joint tuberculosis. *J. Bone & Joint Surg.*, April, 1952, *34-A*, 279–287.

An attempt is made in this paper to assess the results of streptomycin therapy in a group of 118 cases of bone and joint tuberculosis. It was not planned in any case to use streptomycin as a definitive treatment, but only in conjunction with measures which have long been accepted as beneficial.

The best results were obtained when streptomycin was associated with excision in the treatment of a tuberculous focus. When persistent tuberculous sinuses from bone were treated by streptomycin but not by excision, the results were nearly as good, but were slower in appearing, In the treatment of non-discharging bone lesions, the results attributable to streptomycin in 34 cases, appeared to be good in 20 cases, and disappointing in 14. When bone and joint lesions were complicated by miliary tuberculosis of the lungs (five cases), the treatment was modified by increasing the course of streptomycin to 180 grams spread over six months or more, as well as by the use of intrathecal injections. The results were excellent as the pulmonary lesions completely disappeared and it was possible ultimately to treat two spine lesions by bone grafting. Two hip cases appeared to have been arrested, one with no bone destruction. When tuberculosis of bone was complicated by meningitis, the results were temporarily encouraging but ultimately poor.

Resistant forms of tubercle bacilli did not emerge in any patient treated concurrently with both streptomycin and para-aminosalicylic acid, provided the tubercle bacilli were initially sensitive, provided also that para-aminosalicylic acid was used from the commencement of streptomycin treatment, and that the dose of para-aminosalicylic acid was not less than ten grams daily.

The authors believe that there is no doubt that use of streptomycin and para-aminosalicylic acid has reduced the morbidity and has increased the prospects of successful treatment in the field of bone and joint tuberculosis. It is of greatest value in promoting primary healing of a closed wound after excision of a tuberculous sinus and its focus of origin.—*Ralph S. Bromer, M.D.*

A Public Health Service cooperative investigation. Evaluation of streptomycin therapy in a controlled series of ninety cases of skeletal tuberculosis. *J. Bone & Joint Surg.*, April, 1952, *34-A*, 288–297.

This report is an evaulation of 90 patients with skeletal tuberculosis, 40 of whom were treated without streptomycin and 50 of whom were given at least one course of streptomycin in a daily intramuscular dose of 20 milligrams per kilogram of body weight for ninety-one days. The small numbers in the control and streptomycin groups limit the conclusions that were drawn from the findings.

On the basis of roentgenological evidence alone, the condition of the control and streptomycin groups was essentially the same; more than four-fifths of the patients in each group showed improvement roentgenographically at the end of fifteen months. The data appear to substantiate the thesis that, because of the relative avascularity of bone lesions and because a tuberculous focus is usually isolated by fibrous tissue walls, little streptomycin reaches a skeletal lesion. Hence the roentgenographic impression of progress is quite similar for the streptomycin and control groups. However, streptomycin may ameliorate the toxic effects of the tubercle bacillus and, in contiguous areas where the vascular supply is better, may stem the spread of the disease process and bring about systemic improvement. Clinically, the streptomycin patient is in better condition than the control patients at all points of observation. Two of the participating investigators felt, however, that patients who have an isolated focus of osseous tuberculosis, but who are otherwise in good general condition and have no complications or secondary effects due to tuberculosis, should not be treated with streptomycin. Then, if at a later date serious complications develop, the drug may be used with unimpaired efficiency.

On the basis of the patient's condition as judged by roentgenological and clinical data combined, there was a definite superiority among the streptomycin-treated patients. The action of streptomycin appears to produce a generalized effect upon the wellbeing of the patient with skeletal tuberculosis, and upon the secondary manifestations of the tuberculous process as illustrated by cessation of sinus drainage, reduction in the sedimentation rate, return towards a normal hemoglobin level, and evidence of greater functional ability.—*Ralph S. Bromer, M.D.*

Deroy, Mayer S., and Fisher, Harry. The treatment of tuberculous bone disease by surgical drainage combined with streptomycin. *J. Bone & Joint Surg.*, April, 1952, *34-A*, 299–329.

The purpose of the study presented in this paper was to demonstrate the effect of streptomycin therapy in the treatment of tuberculous bone disease in conjunction with the surgical incision of abscesses, debridement of the lesion, and its conversion to a freely draining sinus by the use of gauze packing. The indications for surgical intervention according to the authors, are: (1) progressive advancing tuberculous bone lesion; (2) abscess formation as evidenced by clinical or roentgenographic findings; (3) sequestrum formation.

The principles of treatment are discussed under the following headings: (1) adequate drainage; (2) removal of sequestra; (3) conversion of abscess to a freely draining sinus with gauze packing; (4) administration of streptomycin; (5) splinting of joints postoperatively; (6) encouragement of active motion in peripheral joints; (7) improvement in general nutrition and treatment of anemia; (8) dihydrostreptomycin in cases of toxic reaction to streptomycin. Fifty-two cases are tabulated and analyzed.

The authors conclude that following adequate surgical drainage and streptomycin therapy, destruction from bone and joint tuberculosis has ceased and roentgenograms showed evidence of recalcification and apparent regeneration of bone. No tendency toward reactivation of the lesion, clinically or symptomatically, was noted. In closed bone lesions, they state, the use of streptomycin alone has failed to control the progress of the disease in most cases. In the surgically produced sinuses, subsidence of drainage and closure in periods of time varying from three to sixteen weeks invariably took place. Although the surgically treated lesions, they believed, will heal clinically, new lesions in other parts of the body may develop and progress, despite the administration of streptomycin. While lesions adequately drained surgically are healing, pre-existing sinuses from other lesions may fail to close. The particularly gratifying result was the re-establishment of an apparently normal epiphyseal plate in children with no disturbance of the rate of growth, due to the tendency for bone regeneration to occur in children.

A good functional range of motion in the peripheral joints was retained in almost all cases, with little or no residual pain. In the few cases in which a surgical arthrodesis was performed, fusion tended to occur rapidly. A good functional range of motion has been the usual end result, even when there was roentgenographic evidence of extensive destruction of the joint. The factor of secondary infection, as far as can be determined by the authors, was of no consequence in the arrest and healing of the lesions. —*Ralph S. Bromer, M.D.*

Cloward, Ralph B. Anterior herniation of a ruptured lumbar intervertebral disk; comments on the diagnostic value of the diskogram. *A.M.A. Arch. Surg.*, April, 1952, *64*, 457–463.

The objective findings typical of the herniated lumbar intervertebral disc are not always present and until the rather recent introduction of discography as a diagnostic procedure many ruptured discs were overlooked because of negative myelographic or clinical findings. Discography, introduced by Dr. K. Lindbolm of Sweden in 1950, consists of a direct puncture of the intervertebral disc through the spinal canal (via lumbar puncture) and the injection of a water soluble radiopaque medium into the disc proper. Usually, only 0.5 cc. of the medium (35 per cent diodrast) can be injected into a normal disc but 2 or more cc. of medium can be injected into the abnormal disc. The roentgen study of the normal disc shows a small spherical or oval-shaped, centrally placed nucleus pulposus, while the abnormal disc shows the interspace diffusely or irregularly filled with medium. Diodrast may also be seen to project into the epidural space in the case of a posterior herniation. The patient may experience pain when the medium is injected into an abnormal disc. The author believes this procedure to fulfill the qualifications of the long hoped for diagnostic procedure which would demonstrate the abnormal disc in the absence of objective signs.

Since 1943, this author has been treating all ruptured intervertebral discs by completely removing the disc and replacing it with full-thickness bone grafts for the purpose of fusing the bodies. A specially devised, self-retaining vertebra spreader is used in this procedure.

A case is reported in which there was anterior herniation of a ruptured intervertebral disc. This patient, a forty-two year old waiter, had had chronic low back pain for one year but none of the typical findings of ruptured disc were present. The pain began while the patients was playing volleyball when he jumped to strike the ball and came down stiff-legged. There was severe pain for two weeks following the injury, followed by dull chronic pain.

Discographic study demonstrated a normal disc between the fourth and fifth lumbar vertebrae but at the lumbosacral junction the contrast medium was seen to fill the interspace and completely outline the central irregularity of the annulus. The study also showed the diodrast outlining the anterior longitudinal ligament and what appeared to be a space-taking mass lying between the anterior edges of the vertebrae and protruding anteriorly. A preoperative diagnosis of an anterior herniation of the disc was made. At the time of surgery complete disorganization of the interior of the disc was found. Lying far anterior in the space was an enormous unattached fragment of the intervertebral disc. This fragment produced a round depression in the

anterior longitudinal ligament and accounted for the space-taking mass in the discogram. The entire disc was removed and bone plugs of full thickness were driven into the space. The patient made an uneventful recovery and returned to work in three weeks as a waiter. Three months later, there was solid fusion between the vertebrae and the patient was discharged as cured.

This author is convinced that all of the disc and fragments of the annulus must be removed if the back pain is to be cured and recurrence prevented. Permanent cure is further assured by fusion of the vertebral bodies following complete removal of the intervertebral disc.—*Daniel I. Rousseau, M.D.*

Sutro, Charles J., and Mishkin, Ralph D. Familial nuchal rigidity; a form of hypomobility of the vertebral column which clinically may be misdiagnosed as ankylosing arthritis (antithesis to Ehlers-Danlos disease). *Bull. Hosp. Joint Dis.*, April, 1952, *13*, 155–163.

Nuchal rigidity associated with hypomobility of the vertebral column was noted in 4 members of a family; father and 3 daughters. It is believed that the basis for the hypomobility of the vertebral column was the existence of relatively short ligaments and other soft tissue components on the dorsal aspect of the vertebral column.

The limitation of motion was most marked in the cervical area. Roentgenographic studies revealed no evidence of generalized disease of the skeleton. There was weakness of the flexor muscles in all 4 cases secondary to the restriction of mobility of the vertebral column. The flexion was especially restricted in the cervical areas. Nuchal rigidity in association with an infectious process, such as meningitis or tuberculosis of the vertebral column, must be differentiated from this peculiar familial form of rigidity.—*C. Peter Truog, M.D.*

Burman, Michael. Tear of the sacrospinous and sacrotuberous ligaments. *J. Bone & Joint Surg.*, April, 1952, *34-A*, 331–339.

The sacrotuberous and sacrospinous ligaments are torn by direct, and sometimes violent, injury to the sacrum; the lumbosacral joints may be indirectly strained when the lower half of the sacrum is tilted back. The ligamentous tear is made certain only by the avulsion of bone. In the author's comment he states that the most obvious expression of combined injury of the sacrotuberous and sacrospinous ligaments is the fracture of the sacrum en bloc, to which the ligaments are attached. The small and elastic coccyx does not break. In 2 of his cases, the ischial spine broke by selective tear of the sacrospinous ligament. The selective strain of the sacrotuberous ligament is most likely to break the inferior ramus of the ischium rather than the sacral tuberosity.

There are three adjunct injuries which may occur: contusion or tear of the sacral nerve roots, tear of the piriformis muscle, and rectal prolapse. These are found in only the severest form of this type of injury. Associated injuries in his series included pelvic fracture, laceration of the urethra, and low-back strain; distant injuries included fracture of a cervical vertebra, fracture of a thoracic vertebra, and head injury.

Strain of the ligaments, without avulsion, may heal quickly or slowly. The undisplaced sacral fracture heals, but the displaced fragment may have to be excised. The avulsed ischial spine, like the other tension fractures, may not unit.

The fragment resulting from the fracture through the third sacral foramen is considerably larger than the fragment from fracture through the fourth sacral foramen. Ligamentous tension may avulse the sacral fragment, rotate it, and then displace it, only when the fragment is free at each end. The center of motion is either the upper or the lower point of sacral fracture. If it is the upper point, the fragment rotates proximally through an arc of a circle which is unlikely to exceed 90 degrees. Distal rotation of the fragment with a distally placed center of motion also occurs.

Burman describes a method of analyzing mechanically the rotation of the sacral segment.

Roentgenograms are reproduced to show the various types of fracture occuring in his series.—*Ralph S. Bromer, M.D.*

da Silva, Martins. Spondylolisthésis. Quelques considérations à propos d'un cas de spondylolisthésis double. (Spondylolisthesis; some remarks concerning a case of double spondylolisthesis.) *J. belge de radiol.*, 1952, *35*, 284–303.

In spondylolisthesis of the lumbar spine, L_5 is involved in 82 per cent, L_4 in 13 per cent, and L_3 in 5 per cent of the cases. It is usually recognized between the ages of twenty to forty, and its origin may be congenital, traumatic, or a combination of both. Pain at the involved site and in the lower extremities is due to nerve root compression. Paresthesia and disturbed reflexes are variably present. Flexion of the lumbar spine is limited. Bailey's sign, often positive, is characterized by a small depression in the lumbar region immediately above the painful area and is due to an abnormal prominence of the spinous process of the involved vertebral body.

To be complete, roentgen study must include exposures in frontal and lateral views in supine and erect positions, and in two additional views with the patient standing in hyperflexion and hyperextension. The characteristic findings are: (1) separation at the isthmus; (2) anterior slipping of the vertebral

body; (3) obscured shadow of the corresponding transverse processes; (4) Brailsford's sign, consisting of "bow-line" seen in advanced cases and due to superimposition of two vertebral bodies; (5) increased density also due to superimposition; (6) degenerative arthritic changes.

Several "lining" systems used by various authors are discussed. The one adopted here is Campanario's "central axis basobasal" method. A tracing is made from a film taken in the lateral view. Lines are drawn through the mid-points, between anterior and posterior margins of the involved vertebral body and the one immediately above and below the slipped body. In the author's case, the patient had involvement of L4 and L5. Roentgenograms in multiple views showed that the slipped L4 was stable in type and L5 was unstable. The condition is classified s traumatic spondylolisthesis, multiple (double), mixed type (stable L4 and unstable L5).—*Joseph Zausner, M.D.*

Françon, F., Joly, L., du Lac, G., and Toussaint. Les lésions osseuses de la symphyse pubienne (et des parties voisines) dans la spondylarthrite ankylosante. (Synonyme: spondylose rhizomélique). (Bony lesions of the pubic symphysis, and the adjacent parts, in ankylosing spondylarthritis. Synonym: spondylosis rhizomelic.) *Presse méd.*, March 26, 1952, *60*, 436–438.

The following changes were observed: bony proliferation of the articular surfaces of the symphysis with partial or complete ankylosis, localized areas of rarefaction and "pseudo-widening" of the symphysis. The ischial tuberosities showed proliferative changes with spine formation.

These signs appear in advanced cases where ankylosis of the spine and the sacroiliac joints has already taken place. The anatomical resemblance between the sacroiliac and the intervertebral joints and the similarity of the pathological process taking place in both are stressed. The proliferative changes on the ischial tuberosities might be due to increased muscular pull in an attempt to compensate for the diminished mobility of the skeleton in these cases.—*Karol E. Matzinger, M.D.*

Seyss, R. Die gehaltene transversale Aufnahme der Hüfte zur Diagnose einer Subluxatio coxae congenita. (The diagnosis of congenital subluxation of the hip through the lateral projection.) *Fortschr. a. d. Geb. d. Röntgenstrahlen ver. m. Röntgenpraxis*, March, 1952, *76*, 361–366.

The author advocates roentgenograms in the lateral projection of the pelvis to diagnose congenital subluxation of the hip. It is important to institute early treatment in these cases. However, roentgenographic examination in the usual anteroposterior sagittal projection fails to demonstrate the deformity in the early and borderline stage. This is due to the fact that it shows only caudocranial and mediolateral displacements. The use of contrast media (air, oily or water soluble substances) in the joint is not an indifferent procedure. Stereoscopic and laminagraphic examinations cannot be done routinely, especially on children and infants.

The author uses a simple lateral position with the legs flexed 90° at the hips and the central ray passing through D12. This results in a slight shift of the images of the superimposed hips. In over 100 cases, the author found a constant relationship of the following three points: the anterior inferior corner of the body of L5, the anterior boundary of the acetabulum and the anterior corner of the femoral metaphysis, which are in the same line. Furthermore, the anterior femoral border continues in a symmetrical curve over the anterior contour of the ilium.

In cases of subluxation, this relationship is disturbed and the femoral shaft is displaced upward and dorsally. In more severe cases, the femoral shaft touches the acetabulum or is even superimposed over the image of the acetabulum.—*Salomon Silvera, M.D.*

Freiberg, Joseph A. Para-articular calcification and ossification following acute anterior poliomyelitis in an adult. *J. Bone & Joint Surg.*, April, 1952, *34-A*, 339–348.

A case of acute anterior poliomyelitis is reported in which para-articular calcification and ossification developed, involving the metacarpophalangeal, shoulder and hip joints. Para-articular calcification developing after lesions of the spinal cord and cauda have been reported in the continental literature repeatedly and occasionally in the English literature.

The patient was a white, unmarried woman, thirty years of age. The clinical course and initial spinal fluid studies indicated anterior poliomyelitis as the correct diagnosis. The patient received hot moist packs and passive joint exercise but the author believes that this therapy did not contribute to the process of calcification. The variation from a high to a normal phosphatase figure in the blood serum corresponded with the ossification process of the anomalous areas of calcium deposit or, in other words, increased osteoblastic activity. In view of the clinical findings, the patient had shown evidence of generalized convalescence from her illness, and therefore the calcification and ossification processes were considered to have been completed. From this, Freiberg infers that a systemic disturbance of calcium metabolism existed for a limited period of time.

He concludes that the para-articular process, which in his case was of greater extent than in any previously reported, is due to an extensive lesion of the central nervous system and that it is nonspecific

to the type of this lesion, whether it be traumatic or inflammatory. He suggests that early local peripheral vascular stimulation might be beneficial, and recommends that at the conclusion of the self-limited para-articular ossification, surgical removal be employed to re-establish joint mobility.—*Ralph S. Bromer, M.D.*

Hauch, Paul P. Arthrography—from the symposium at the 6th International Congress of Radiology, London, 1950. Part I. A comparative study of arthrography of the knee joint. *Brit. J. Radiol.*, March, 1952, *25*, 120–129.

Three types of arthrograms of the knee were produced by the author. Vacuolization was accomplished by applying traction as well as forced abduction or adduction of the leg on the thigh to permit visualization of the medial or lateral compartments of the joint. Diodrast was injected in another group for contrast study, and in a third group oxygen was used as the contrast medium. Manipulation of the knee was also used in filming when oxygen was injected, but it interfered when diodrast was used.

Comparison showed that each of the three methods demonstrated certain types of pathological change. Vacuolization was of little value with any abnormality other than abnormal menisci and either injection method was superior to vacuolization for demonstration of the menisci. In addition, oxygen injection was much more valuable than was diodrast injection in assessing the condition of the synovia, the fat pads, the collateral ligaments, and intra-articular foreign bodies.

The author emphasizes that arthrography is not necessary in evaluation of acute injury but is most valuable in a complete examination of an individual with chronic derangement of the knee. In his series of cases, oxygen injection provided an accurate diagnosis in 82 per cent, while diodrast injection permitted a definite diagnosis in 37 per cent and a questionable diagnosis in 37 per cent. In addition to this, it must be remarked that oxygen injection provides a higher degree of observability.—*Ernst F. Lang, M.D.*

Borow, L. S. Arthrography—from the symposium at the 6th International Congress of Radiology, London, 1950. Part II. The evaluation of pneumoarthrograms. *Brit. J. Radiol.*, March, 1952, *25*, 129–134.

The author presents examples from his series of 369 patients in whom pneumoarthrograms of the knee were made. He points out that the history and physical examination seldom yield enough data to establish a diagnosis. He uses between 90 and 150 cc. of filtered air to distend the joint and makes roentgenograms to demonstrate particularly the semilunar cartilages, synovial outpouchings, osteocartilaginous bodies, foreign bodies, arthritic changes, separate ossifications and bipartite patellae. The cruciate and collateral ligaments, the fat pads, and the articular cartilages are also well shown, Examples of several types of meniscal injury are well illustrated.—*Ernst F. Lang, M.D.*

Nelson, D. H. Arthrography—from the symposium at the 6th International Congress of Radiology, London, 1950. Part III. Arthrography of the shoulder. *Brit. J. Radiol.*, March, 1952, *25*, 134–140.

The technique and interpretation of arthrograms of the shoulder are described by the author who uses a water soluble medium containing iodine in contrast to the Scandinavian workers who prefer air. The technique of injection is difficult and the most experienced worker will encounter failures. Normal shoulder arthrograms are characterized by visualization of the thin superior meniscus shaped joint space which outlines the head and which is limited precisely at the anatomical neck, and in addition there is filling of the subcoracoid bursa, the inferior joint recess, and the synovial sheath of the tendon of the long head of the biceps. If the subacromial bursa is filled, the author feels that a bursal effusion must necessarily have been present. The examination is of considerable value in demonstrating the existence and extent of tears of the musculotendinous cuff and the size and position of intra-articular loose bodies. The examination is felt by the author to be of no value in investigation of a frozen shoulder.—*Ernst F. Lang, M.D.*

Leb, A. Arthrography—from the symposium at the 6th International Congress of Radiology, London, 1950. Part IV. Peripheral ischaemia as the basis of joint disease (serial angiography of the periarticular blood vessels). *Brit. J. Radiol.*, March, 1952, *25*, 140–144.

The use of angiography in the investigation of joint abnormality by demonstration of the blood supply of the periarticular structures is described by the author. This method expands the usefulness of roentgenology in the study of the joints. Serial angiograms are made after injection of thorotrast into the brachial artery. The choice of the site of injection and the medium was made to minimize mechanical interference and vascular spasm and to permit visualization of the fine periperal vessels.

Roentgenograms of a hand with polyarthritis deformans and cartilage atrophy display narrowed digital arteries with peripheral ischemia as a basis for the cartilage atrophy. Other similar cases show involvement of both arteries and veins. The latter become dilated with marked slowing of circulation. Roentgenograms of one patient are presented and these show no abnormality in a plain roentgenogram

made without contrast medium, but the patient complained of considerable rheumatic pain. The basis of this was demonstrated by angiograms which revealed extensive latent vascular damage. The author suggests that therapy at this point would prevent or at least considerably delay the development of irreparable articular deformities.—*Ernst F. Lang, M.D.*

Wilson, William J., and Jacobs, Julian E. Patellar graft for severely depressed comminuted fractures of the lateral tibial condyle. *J. Bone & Joint Surg.*, April, 1952, *34-A*, 436–442.

When the knee joint is forcefully struck from the lateral aspect, the strong tibial collateral ligament acts as a fulcrum, and the lateral femoral condyle is driven against the lateral surface of the tibia. The tibial collateral ligament may rupture, the lateral condyle may separate and be driven downward, or the lateral femoral condyle may be driven down into the upper end of the tibia with varying degrees of depression and comminution of the articular surface. In the first instance, treatment usually presents no great problem. In the second, methods of treatment already in use are satisfactory, but, when comminution and depression occur to an appreciable degree, post-traumatic changes are probable and satisfactory reduction is occasionally impossible to obtain.

The authors thought that after patellectomy a satisfactory knee might be obtained in cases of comminution and depression of the fragments by utilizing the articular surface of the patella to replace the destroyed surface of the tibia. The patella was removed and rongeured down to cancellous bone on its tendinous surface. The medial facet was removed and the lateral facet was set upon the end of the tibia to fill the defect and to replace the articular cartilage. Fixation was accomplished by means of an oblique metal screw. A long cast was applied to the limb for one month, after which time partial weight-bearing on crutches was allowed. Five cases were operated upon, 1 fixed with a screw, 1 fixed with staples and 3 without fixation. The authors believe that their cases show that the basic principles of the procedure are sound regardless of any variation in technique.

Experience has shown that stability of the joint is obtained immediately after the insertion of the patellar graft into the defect. No evidence of aseptic necrosis was noted either in the patellar graft or in the compressed bony area beneath it. They regard the function of the knee in different age groups of their patients as better than they have obtained with other methods.

Illustrative roentgenograms of the fractures with end results are included in the paper.—*Ralph S. Bromer, M.D.*

Badgley, Carl E., O'Connor, Sylvester J., and Kudner, Donald F. Congenital kyphoscoliotic tibia. *J. Bone & Joint Surg.*, April, 1952, *34-A*, 349–369.

The term kyphoscoliotic tibia is suggested by the authors as a descriptive name for the deformity called by various authors "congenital bent tibia," "congenital kyphotic tibia," "intra-uterine fracture of the tibia," and "congenital bowing of the tibia." The characteristic features of the entity are: 1. Congenital bowing of the tibia is a constant feature with anterior or posterior convexity, generally associated with rotation and a lateral or medial bowing. 2. The lesion occurs uniformly in the distal portion of the central third of the tibia. 3. Pathologically, there is evidence that the lesion is located primarily in the diaphyseal center, at the site corresponding to the location of the primitive mesenchymal bar, and the site of origin of the early cartilaginous anlage for the primary ossification center. 4. Roentgenographically, an ossified mass is constantly found at the site of the deformity on the concave side of the curve. The trabeculations in this dense area are generally arranged radially from the apex of the curve, and usually do not lie in the axial direction. 5. Ten of the 20 cases of the authors' series showed a definite tendency to spontaneous correction. 6. There is marked potential danger of pathological fracture in these cases and non-union is a common complication. 7. Associated deformities have occurred with such frequency that they must be regarded as a definite part of the clinical entity, even though they are not a constant finding. Associated deformities which occur are hyperplasia or partial gigantism; hypoplasia involving the fibula or the foot, the talus, proximal end of the femur and congenital amputation of the foot and ankle; syndactylism; skin lesions as café au lait markings, and neurofibromatosis; deformities of the feet, such as talipes equinovarus, talipes calcaneus and calcaneovalgus. 8. Eleven of the 20 cases showed an associated dimpling of the skin at or near the apex of the curved tibia.

Ten of the 20 patients of the series illustrated various features characteristic of congenital kyphoscoliotic tibia, such as a dense bony mass on the concave side of the affected bone, spontaneous correction of the deformity, posterior bowing, cystic changes, associated deformities such as syndactylism and pseudarthrosis.

A detailed review of embryological, histological and clinical studies of normal and abnormal bone growth is included in the paper. The authors state that regardless of the method by which these deformities develop, the original fault must occur in the early phase of development of the limb bud prior to ossification of the skeleton. It is quite possible that a neurovascular abnormality might produce damage only to soft tissues, producing an ischemic lesion in

the muscles of the extremity akin to that seen in arthrogryposis. Minimal damage to musculature might produce an alteration in development such as that recently demonstrated by Bechtel and Mossman in a three month old fetus with club-foot. The possibility of an hereditary or environmental fault of neurovascular origin must be given serious consideration in the explanation of the lesion, according to the authors.—*Ralph S. Bromer, M.D.*

Bound, J. P., Finlay, H. V. L., and Rose, F. Clifford. Congenital anterior angulation of the tibia. *Arch. Dis. Childhood*, April, 1952, *27*, 179–184.

The authors report 2 cases of congenital anterior angulation of the tibia in infants. In 1 patient there was angulation of each tibia and fibula at the junction of the middle and lower thirds. The posterior portion of the cortex was thickened at the site of angulation. The other patient revealed several deformities of the skeleton, including anterior bowing of both legs, equinus deformity of the feet, flexion of the metacarpophalangeal and proximal interphalangeal joints, pigeon-breast deformity and palgiocephaly. Numerous skin dimples were noted at the sites of deformity.

Theories of etiology are discussed and include union of an intrauterine fracture, heredity, intrauterine failure of growth in length of developing muscle unit, excessive intrauterine pressure, biochemical or hormonal influences.—*James F. Martin, M.D.*

Carpenter, Earnest B., Dobbie, John J., and Siewers, Christian F. Fractures of the shaft of the tibia and fibula; comparative end-results from various types of treatment in a teaching hospital. *A.M.A. Arch. Surg.*, April, 1952, *64*, 443–456.

This interesting study deals with the treatment and results of treatment of fractures of the shafts of the tibia and fibula in a teaching hospital. Only patients above ten years of age are included in the study and fractures of the condyles, plateau and malleolus of the tibia are not included. There were 135 fractures in 123 patients; 12 patients had fractures in both legs. The cases were divided into five categories: simple fracture; simple comminuted fracture; compound fracture; compound comminuted fracture; and compound comminuted multiple fracture.

All fractures were treated as emergencies with reduction being carried out shortly after the patient's admission.

Sixty-one fractures were treated by closed reduction, using a reinforced gauze traction hitch applied at the ankle. Traction was applied by the assistants while reduction was performed and a firm, tight fitting cast applied. All casts were routinely split to allow for edema.

Fifty-one compound fractures were treated by wound debridement and closed reduction. These patients also received antibiotics and tetanus antitoxin or toxoid routinely.

Eleven cases were treated with open reduction but without internal fixation. Twenty-four fractures were treated with open reduction and internal fixation with some type of plate screw or wire.

There were 4 deaths in this series of 135 fractures. Three deaths were due to other multiple injuries sustained at the time of leg fracture. One death was due to toxemia of massive infection. This patient died four hours after amputation which was performed on the sixth day after injury.

There were 10 cases of postoperative infection with bone involvement, all occurring in cases of compound fractures. Five fractures healed without further surgery and an additional fracture healed following sequestrectomy. Four patients had amputations because of infection; 2, because of gas producing organisms and 2 because of persistence of infection over a long period of time.

There were 5 other cases in which amputation was done because of ischemic necrosis secondary to major vessel trauma. All of these fractures were compound and of severe degree and it is felt that vascular trauma led to the thrombosis. One patient had severance of a major vessel.

Nonunion developed in 6 cases, 1 of which described above, had an amputation two years after injury. The 5 remaining cases of nonunion healed following bone-graft surgery.

Those cases in which there was not sufficient union present at the end of five months to permit weight bearing without support were classed as delayed union. There were 22 cases of delayed union and all went on to bony union without additional surgery. It was felt that the delayed union was associated with the extensiveness of multiple fractures and with the inability to employ the short leg walking casts at any time during immobilization.

Following a detailed breakdown of all cases in the five groups and the results obtained from the various types of treatment, the authors conclude that the best results were obtained in those patients who received the simplest type of treatment. Soft tissue injury very definitely contributed to the complications and, in some cases, presented more of a treatment problem than the fracture. Firm immobilization of the fracture is essential for healing of the wound. The authors feel that the more extensive the compound wound, the greater is the indication for internal fixation of the underlying fracture. The most important aspect of the treatment of these fractures is the snug fitting cast with a minimum of sheet wadding, which can be effectively applied by use of the gauze traction hitch.—*Daniel L. Rousseau, M.D.*

Badgley, Carl E., and O'Connor, Sylvester J. Conservative treatment of fracture of the tibial plateau. *A.M.A. Arch. Surg.*, April, 1952, *64*, 506–515.

This article describes a conservative method of treatment of fractures of the lateral plateau of the tibia. Skeletal traction is produced with the use of a Kirschner wire through the distal tibia and fibula or the os calcis and the extremity is then placed in a Thomas splint with 10 to 15 pounds of traction. The knee is placed in 14 to 20 degrees of flexion. The knee joint is aspirated to relieve the pressure resulting from hemarthrosis. Within twenty-four to forty-eight hours vigorous active quadriceps exercises are instituted and continued throughout the course of treatment. The extremity remains in traction for eight to twelve weeks and is then placed in a bivalved cast or a long double upright caliper.

This method was used in 17 patients with good functional results in all cases. Five case histories are given. The authors stress the necessity for vigorous quadriceps exercises in an attempt to obtain maximum knee-joint stability.—*Daniel L. Rousseau, M.D.*

Mangalik, V. S., and Lal Mehrotra, R. M., Adamantinoma of the tibia; report of a case. *Brit. J. Surg.*, March, 1952, *39*, 429–432.

Adamantinoma of the tibia is a rare condition; apparently only 12 cases are reported in the literature. The authors report a thirteenth case occurring in a forty year old male from India.

There was extension of the tumor through the cruciate ligaments to the femoral condyles with metastasis to the regional inguinal lymph nodes; a similar tumor was also present in the fibula of the same leg.

Clinical, roentgenological, and pathological data are presented.—*Arthur A. Brewer, M.D.*

Essex-Lopresti, Peter. The mechanism, reduction technique, and results in fractures of the os calcis. *Brit. J. Surg.*, March, 1952, *39*, 395–419.

Fractures of the os calcis may be classified as involving or not involving the subtaloid joint.

Twenty-five per cent of the fractures in this series did not involve the subtaloid joint; the results were universally good. Dividing the cases into those treated by plaster immobilization or by exercise, the figures for return to work and recovery to stability were a little in favor of exercise.

Fractures involving the subtaloid joint are important because the results are so likely to be bad. The author further divides these fractures into what he describes as the tongue fracture and the joint depression fracture. These are two distinct but closely related patterns, produced by a similar mechanism, each requiring a distinct method of reduction.

The author recommends reduction of the tongue type fracture by means of the inserted Gissane spike, which is used to maneuver the tongue fragment into position. In the joint depression fracture open reduction is recommended, the fragments being held in position with the spike.

Following satisfactory reduction of the fragments, the author considers early exercise of paramount importance. He applies a "shoe" plaster incorporating the spike, which covers only the foot and heel; it passes below the malleoli and leaves the toes free. The exercises, which are described in detail, are started twenty-four hours after surgery.

Operation has been limited to patients below fifty years of age. In the older patients exercise therapy was found to be superior in all types of fracture.

The author presents his procedures and opinions in considerable detail. For instance, there are 89 illustrations or roentgenographic reproductions. Study of the original article is recommended.—*Arthur A. Brewer, M.D.*

Rapp, Ira H. Adolescent coxa vara; clinical considerations and aspects of treatment. *South. M. J.*, March, 1952, *45*, 177–183.

There has been marked evolutionary change in thought concerning adolescent coxa vara in the past few years. The disease at one time was attributed by many to tuberculosis, rickets or osteomalacia. A plea is made for early recognition and a working plan is given for treatment. A careful study of the patient's symptoms and the taking of stereoscopic and lateral roentgenograms of the hip are necessary to detect slipping.

The etiology is discussed. The author believes that more stress should be laid on the endocrine and hormonal investigations as the disease has a predilection for the obese child with retarded genital development.

The treatment is one of individualization. Manipulation has fallen into disrepute except in the acute stage where results are often dramatic. Pinning in situ has not been satisfactory. The author favors nonweight-bearing splints and recumbency in bed. The treatment in the late stages is discussed; he believes that fusion "is the court of last resort."—*Robert J. Reeves, M.D.*

Pointon, R. C. S. Fractures of neck of femur following irradiation of the pelvis. *Proc. Roy. Soc. Med.*, March, 1952, *45*, 135–139.

The occurrence of fracture of the neck of the femur as a result of roentgen irradiation of the pelvis for malignant disease is an uncommon but well recognized complication of such treatment.

Four cases were seen at the University College

Hospital, London; one with bilateral fractures. These 4 cases occurred in a series of several hundred patients treated similarly for carcinoma of the cervix uteri. Irradiation consisted of three insertions of intracavitary radium followed by deep roentgen therapy to the pelvis through two anterior oblique, two posterior oblique and two lateral fields. Each field received a total of 2,500 r delivered in six weeks.

The incidence of hip fracture is much higher in this group than that seen in equivalent age groups of the general population.

Three to fourteen months following irradiation the patients noted vague pain in the affected hip, lateral thigh and corresponding half of the pelvis. The pain was never severe and for some time there was no interference with hip joint function. At the onset of symptoms recurrent disease was suspected, but the carcinoma in all 4 cases was found to be controlled.

Pelvic roentgenograms were considered to be negative, although retrospective review of the films revealed, in some instances, a fracture that was not recognized initially. Seventeen to thirty-seven months after completion of roentgen therapy, clinical and roentgenographic examination revealed easily recognizable fractures of the femoral necks.

After 1947 the pelvic fields for irradiation of carcinoma of the cervix have been rearranged by the author, using smaller fields and omitting the lateral fields.

Since adoption of the new technique no femoral neck fractures have been noted. A typical case of femoral neck fracture is given.—*Donald R. Bernhard, M.D.*

Marks, Kenneth L. Flake fracture of the talus progressing to osteochondritis dissecans. *J. Bone & Joint Surg.*, Feb., 1952, *34-B*, 90–92.

The patient, in the case report presented in this paper, suffered a flake fracture of the superolateral angle of the talus. Presumably the fragment was buckled off the lateral border of the talus by the contiguous articular surface of the lateral malleolus. The fracture of the talus did not unite and with consequent underlying excavation the lesion then resembled osteochondritis dissecans. Thickening around the ankle joint and pain on extremes of motion in all directions developed. The fragment finally appeared to be separating from the talus. The site of the separation in this patient was not the most common for osteochondritis of the talus.

The direct relationship between injury and the onset of osteochondritis dissecans has been noted in the literature. The sequence of events in this case was observed roentgentographically and clinically for a period of two years from the date of the injury. —*Ralph S. Bromer, M.D.*

Hafner, R. H. V. Localized osteochondritis (Scheuermann's disease). *J. Bone & Joint Surg.*, Feb., 1952, *34-B*, 38–40.

The multiple form of Schuermann's disease (adolescent kyphosis; osteochondritis vertebralis juvenilis) affecting the thoracic spine is well recognized, but Hafner states there is a localized form occurring in the thoracolumbar region which, although well known, does not seem to have attracted much attention. It is important that this condition be distinguished from tuberculosis, with which it is easily confused in the early stages. The clinical similarity may be close, but once the roentgenographic appearances are recognized the difficulty, Hafner states, in distinguishing between the two conditions largely disappears.

Four cases are reported in this paper of localized osteochondritis, all in adolescents, their ages varying from fourteen to seventeen years at the time of onset of symptoms. All complained of pain in the thoracolumbar spine, and in 1 case the pain was referred to the loin. There was tenderness on palpation over the affected vertebrae. Muscle spasm was slight or absent and there was no muscle wasting. The symptoms subsided rapidly after immobilization of the spine in bed or in a plaster jacket or brace.

Hafner suggests that the following fact would seem to indicate that the symptoms may not be due to the bone changes shown in the roentgenograms and that they may in fact be due to a posterior protrusion of the intervertebral disc: (1) the symptoms are intermittent and (2) they are associated with vigorous exercise or heavy work. In 1 of his cases there was root pain. The roentgen changes may be coincidental or they may be consequent upon the intervertebral disc lesion. From the point of view of treatment, the important thing is to realize that these changes are not due to an infective lesion.

The roentgen examinations in his cases showed changes indicative of osteochondritis in the affected vertebrae.—*Ralph S. Bromer. M.D.*

Bingold, A. C. Joint changes in neurofibromatosis. *J. Bone & Joint Surg.*, Feb., 1952, *34-B*, 76–79.

The author presents 2 illustrative cases in this paper, with an analysis of the joint changes found in neurofibromatosis. Apparently the joint changes have not been previously described in the literature.

About one-third of the reported cases of skeletal neurofibromatosis have joint changes which fall into three main groups: (1) dysplasia, (2) sclerosis of the articulating bone end, and (3) secondary osteoarthritis.

Dysplasias have been reported at the hip, at the foot and ankle, and in the hand. In the hip, coxa valga with associated shallow acetabulum, coxa vara and congenital dislocation of the hip have been noted.

At the foot and ankle, calcaneus deformity associated with distortion, underdevelopment and displacement of all the tarsal bones, congenital rocker foot, congenital flat foot due to misshapen tarsal bones and lateral displacement of the talus and calcaneus, have been reported. In the hand, hypertrophy of the bones of the first and second digits associated with expanded bone ends occurs.

Sclerosis of the articulating bone ends has been observed at the hip where the acetabulum is sclerosed associated with radiolucent areas; at the ankle, where the lower part of the tibia and the talus are affected, and at the wrist involving the distal end of the radius sometimes with sclerosis and hypertrophy of the carpal bones.

Secondary arthritis may occur in abnormal joints such as coxa valga, in normally developed joints subjected to abnormal forces such as a short femur causing rocking of the knee with every step or forward bowing of the tibia producing abnormal compression of the ankle.

The search of the literature revealed no record of shoulder or elbow lesions in patients suffering from neurofibromatosis.—*Ralph S. Bromer, M.D.*

Waugh, W. Dysplasia epiphysialis multiplex in three sisters. *J. Bone & Joint Surg.*, Feb., 1952, *34-B*, 82–87.

Dysplasia epiphysialis multiplex, first described by Fairbank, is characterized by dwarfism, stubby digits and mottling or irregularity in density and outline of the developing epiphyses. The condition is said not to be familial but in previous reports some cases of familial occurrence have been recorded to which the author adds the cases of his 3 patients.

The 3 sisters had irregularity of ossification of the epiphyses which consisted of early appearance of the centers with early fusion, which may have been a factor in the production of their relatively short statures. In the roentgenograms shown in the paper some of the changes were: flattening of the capital epiphyses of the femur, short and stunted metatarsals and metacarpals, and abnormal shape of the capitellum of the radius with consequent subluxation of the radial head.

Waugh admits that there is some variation from Fairbank's described pattern of the roentgenographic changes in that the epiphyses have appeared early and fused early in his cases. This is a substantial difference, but since it is impossible to make sharp distinctions of growth abnormalities he regards it correct to include them under the title of dysplasia epiphysialis multiplex.

He suggests that treatment in the form of relief from weight-bearing is unnecessary and should not be contemplated because of the roentgenographic appearances. If dysplasia epiphysialis multiplex is diagnosed early in life there should be no need to give the parents a dismal prognosis for dwarfism is seldom severe, deformity has been troublesome only in a small proportion of the reported cases, and function is invariably good.—*Ralph S. Bromer, M.D.*

Matheson, W. J., and Markham, Mary. Infantile cortical hyperostosis. *Brit. M. J.*, April 5, 1952, *1*, 742–744.

Two cases of infantile cortical hyperostosis are added to the literature. Each showed two of the three salient features of this disease, namely, irritability and cortical thickening of bone. The third, localized swelling of the soft tissues, was absent. Although infantile cortical hyperostosis is usually considered to be a benign disease, 1 of the cases died of secondary infection. Postmortem studies of the involved mandible showed periosteal thickening microscopically. The periosteum was thickened by numerous osteoblasts which produced an immature form of bone with imperfectly developed haversian systems. It is this type of newly formed bone which subsequently fuses with the cortex to produce the palpable bony swelling. The authors suggest that the term "infantile cortical hyperostosis" is a misnomer, inasmuch as it is the periosteum which is involved in the pathologic process.

Other investigators have biopsied the affected soft tissues in this disease and have found necrosis and fibrosis of muscle with internal proliferation of the blood vessels. This vascular obliteration is observed in the vessels of the periosteum and it is felt that this diminution in blood supply stimulates the new bone formation which is so characteristic of this disease.

As a result of these studies the authors believe that infantile cortical hyperostosis is a primary disease of the blood vessels rather than a primary disease of bone.—*Gerald Lavner, M.D.*

Gain, Douglas D., and Lawson, Donald E. Osteogenesis imperfecta. *Radiology*, Feb., 1952, *58*, 221–223.

Osteogenesis imperfecta may be either the *nonhereditary congential type* which appears in utero or at birth, or the *hereditary type*. It is a rare disease occurring at any age and in both sexes.

The roentgen findings of the skull closely simulate cleidocranial dysostosis. Early suture lines are difficult to delineate; later they are marked by the development of wormian bones. There is commonly an increase in the bitemporal diameter. The characteristic findings in long bones are a thin cortex and a large medullary cavity. There is some osteoporosis. The epiphyses may present a foamy appearance. Bowing and angulation of the shafts of the long bones are the rule due in part to malunion of true fractures. The spine may show a softening of the vertebral bodies with flattening and wedging and associated ballooning of the intervertebral discs.

Associated changes such as the blue sclerae, the

blood chemistry and pathology are discussed. A successful form of treatment has not yet been discovered.

A case of osteogenesis of the non-hereditary congenital type is reported. Two figures show multiple fractures three days after birth which demonstrate callus formation at sixteen days of age.—*Everett E. Seedorf, M.D.*

Savignac, Eugene M. Chondrodystrophia calcificans congenita; report of a case. *Radiology*, March, 1952, *58*, 415–420.

The author presents a case of chondrodystrophia calcificans congenita adding 1 more to the 22 cases previously reported in the literature. This disease is, as the name implies, congenital and is seen only in infancy. The diagnosis is made with certainty only by roentgenographic study.

The characteristic roentgen feature is stippling by minute deposits of calcium in the epiphyseal areas of the long bones and in other areas of the body where cartilage is present, as in the tarsal and carpal areas, the ossification centers of the pelvis, sternum, vertebrae, the chondral ends of the ribs, the intervertebral discs, and even the thyroid cartilage. The long bones also show the typical malformations of condrodystrophy. In most of the reported cases, bilateral congenital cataracts as well as a peculiar stiffness of the large joints were present. No definite hereditary, familial or sex prediliction has been noted.—*Donald N. Dysart, M.D.*

Heiser, Saul, and Schwartzman, Joel J. Variations in the roentgen appearance of the skeletal system in myeloma. *Radiology*, Feb., 1952, *58*, 178–191.

This review of the roentgen findings in 62 cases of proved myeloma revealed a wide range in the appearance of the skeletal system from normal to extreme bone destruction. To a great extent, the findings depended on the duration of the disease. Eight cases (13 per cent) were encountered in which no bone alteration was demonstrable. Two of these came to autopsy and only histopathologic examination established the diagnosis.

A uniform type of bone involvement was rarely found. Typical combinations were: (1) discrete punched-out lesions in the skull with osteoporosis of the ribs and severe osteoporosis and partial collapse of the vertebrae, or (2) a normal skull with borderline destruction in the ribs, circumscribed destructive lesions in the pelvic bones, and osteoporosis of the spine. In only 8 cases (13 per cent) did skeletal surveys disclose so-called "punched-out" lesions in all the bones involved.

Demineralization of varying degree, nonspecific destruction, and collapse were the common vertebral findings. The presence of a paravertebral soft tissue mass or extension of the area of destruction across the intervertebral disc should arouse suspicion of myeloma. Pathologic fractures were seen in 43 (70 per cent) of the 62 cases studied. No instance of persisting solitary myeloma was encountered.—*Arno W. Sommers, M. D.*

Schmauss, Albert K. Plasmocytom (multiples Myelom) und Trauma. (Plasmocytoma [multiple myeloma] and trauma.) *Chirurg*, March, 1952, *23*, 115–119.

Review of case histories of patients with multiple myeloma shows a large number of these patients with previous history of trauma to which the patients, attribute their symptoms. Geschickter and Copeland among others, state that in a third of the patients with multiple myeloma a history of trauma has been associated. Numerous authors are quoted who have considered the relationship between trauma and plasmocytoma, and several such case reports are cited. On the other hand, some authors are mentioned who believe that trauma has no relationship to plasmocytoma but that as a result of the disease the bones become less resistant to trauma and thus become fractured more easily. Thus, the first symptom of the disease may be manifested after trauma.

The author contends that the previous concept that multiple myeloma is a neoplasm of the bone marrow of multicentric origin is now considered to be false and it has been demonstrated definitely that the tumor is made up of myeloid plasma cells and its immature forms. Accordingly, Apitz has suggested that this disease be called plasmocytoma. Furthermore, Apitz has shown that plasmocytoma does not arise as a primary multicentric tumor, but that this represents a more advanced stage of the disease. The first stage of the disease is a tiny circumscribed cell growth in the bone marrow. Ribbert had also believed that multiple myeloma begins in one place and produces metastasis by the way of the blood stream.

On the basis of these new attitudes concerning this disease, it may be proper to consider again the question of causal relationship with trauma. One should approach the problem of trauma with plasmocytoma as one does between trauma and sarcoma of the bone. Certainly, for bone sarcoma there is a whole group of observations in which the relation of trauma is beyond doubt.

The author presents 2 cases of plasmocytoma in which he believes that causal relationship with trauma was very possible. The first is that of a twenty-two year old man who sustained bilateral mandibular fractures in August, 1944. Almost three years later, he was hospitalized because of marked weakness in his hands, sternum and one leg. Several months later, he had a spontaneous fracture of the neck of the left femur while in the hospital. Roentgen examination at this time revealed multiple myeloma, confirmed by biopsy of the left femur. The second

case concerns that of a forty-five year old individual who had always been in good health. In 1943, he sustained a gunshot wound of the body of the fifth lumbar vertebra and a fracture of the left transverse process of the fourth lumbar vertebra, demonstrated on roentgen examination. Since May, 1948, he complained of severe pains in the sacrum. Roentgen examination of the spine showed the first lumbar vertebral body to be compressed. Urography showed a large filling defect in the right kidney. Nephrectomy followed by radiation therapy was carried out in August, 1948. Histologically, there was no evidence of carcinoma of the kidney, but there was retention of proteins in the uriniferous canals and destruction of the canal system. Postoperatively, Bence-Jones protein was found in the urine and serum protein was 9.6 mg. per cent. Skeletal roentgen examination showed "typical" destructive areas of multiple myeloma in the skull. The patient died of uremia in a few weeks.

The author considers the strong possibility that the myeloma in both of his cases was caused by injury, primarily because of the extreme rarity of this disease in a twenty-two year old patient and even in one forty-five years of age. In addition, several criteria associating injury with disease were fulfilled: (1) The injury must be in that area which later becomes the seat of the neoplasm. (2) The injury must be of such a nature that it produces tissue and metabolic disturbances of long duration. (3) The time interval between the effects of the injury and the first manifestation of the neoplasm must correspond to the time it takes for such a neoplasm to develop. In the author's cases, this interval was two and one-half and four years.

In conclusion, the author states that in both of his patients, who were in perfect health before injury since they were both in the front line during World War II, there is a definite relationship between injury and plasmocytoma.—*Samuel Richman, M.D.*

Cameron, J. A. P., and Marsden, A. T. H. Malignant osteoclastoma; report of a case. *J. Bone & Joint Surg.*, Feb., 1952, *34-B*, 93–96.

In this paper a case is described of a malignant osteoclastoma in which death occurred from pulmonary metastases. The patient was a Chinese male, aged thirty-four, with a large swelling of the right knee. Roentgen examination disclosed a lesion which was diagnosed osteoclastoma. The temperature of the skin was slightly raised and there was egg-shell crackling on pressure. The inguinal lymph nodes were not enlarged and there were no signs of extension to the lungs. Disarticulation of the right hip was performed.

Twenty-one months later, he was readmitted with a history of having coughed up half a pint of blood. A roentgen examination of the chest then showed almost complete opacity of the right hemithorax and patchy opacities in the left lung. Two months later, death occurred.

In the histopathologic examination the general appearance was that of an osteoclastoma. Only the plump vesicular nuclei of the stromal cells, rather irregular in shape and varying in size and degree of hyperchromatism, suggested that the neoplasm was not as benign as an osteoclastoma usually is. In the metastatic areas in the lungs all the nuclei were markedly hyperchromatic. The proportion of spindle cells was higher than in the primary growth, although, in any field, cells with round or oval nuclei were also present. A few mitotic figures were found in the stromal cells.

The histopathological appearance, the authors state, was not precisely that of a benign osteoclastoma but there was sufficient resemblance to enable it to be recognized as an osteoclastoma. The history was comparatively short and it therefore seemed more probable that the growth was malignant from the first than that it was originally a benign tumor which later became malignant.

It is suggested by the authors that perhaps much of the controversy today on the existence of a malignant osteoclastoma is really a dispute over nomenclature. If it is desired to use the term osteogenic sarcoma for malignant osteoclastoma, some qualification is necessary. Stewart in 1922 suggested the name osteoclast sarcoma but this has seemed to have received no general acceptance. Willis, quoted by the authors, has stressed that "benign" and "malignant" are merely terms which conveniently express the probable behavior of a neoplasm; they do not represent a fundamental biological characteristic. It would therefore seem wrong to suggest that an osteogenic sarcoma may arise in an osteoclastoma as a completely new and different neoplasm. If an osteoclastoma is malignant or becomes so, it remains the same neoplasm and may still show sufficient differentiation toward the formation of osteoclasts to determine its type. The suggestion that an osteogenic sarcoma arises as a second and unconnected neoplasm in the neighboring non-neoplastic tissue lacks proof and the published cases do not suggest that it has ever occurred.—*Ralph S. Bromer, M.D.*

Lawson, T. L. Fibular transplant for osteoclastoma of the radius. *J. Bone & Joint Surg.*, Feb., 1952, *34-B*, 74–75.

In this paper the case of an African policeman in whom roentgen examination disclosed an osteoclastoma of the distal end of the radius is reported. The lower end of the radius was excised well above the site of the tumor and a graft consisting of the upper end of the left fibula was inserted and fixed with vitallium screws. The roentgenogram after operation demonstrated the remarkable similarity

between the fibula and the radius. Convalescence was uneventful except for a large hematoma at the donor site.

The author comments that the patient's condition was satisfactory a year after operation, but cases have been recorded in which massive grafts implanted after resection for osteoclastoma have themselves become the site for a similar tumor, although the excision had been wide. In his case, there was undoubtedly some contamination of the wound with tumor cells at operation but no recurrence had appeared in the interval of a year following operation.—*Ralph S. Bromer, M.D.*

Aftalion, B. Un caso de discondroosteosis, del grupo del "Gargoilismo." (A case of dyschondro-osteosis of the group "gargoylism.") *Bol. Inst. pat. méd.*, March, 1952, *7*, 48–53.

The case of a nine year old male child is presented. He was the third child of a mother who had an appendectomy in the third month of pregnancy. After breech delivery the child suffered from icterus neonatorum for one month. The deformities described were present at birth.

The head was scaphocephalic. The pinnas of the ears were atrophic, with irregular implantation; pronounced hypertelorism with arched eyebrows was also noted. Ptosis, poor pupillary reaction to distance, broad-based nose (saddle-shaped), thick neck, dorsal scoliosis, dorsolumbar spina bifida, globular abdomen with umbilical hernia and diastasis of rectus muscles, bilateral cryptorchidism, prominence of iliac wings, short forearms, polydactylia with retraction of tendons to distal phalanges, wrists in palmar flexion, short legs curved outward and backward, and pedal polydactylia (eight toes) were all present.

Roentgenographic findings included dorsolumbar scoliosis and spina bifida, absence of fifth lumbar vertebra, bilateral coxa valga, polydactylism, increased vertical diameter of skull, synostosis of first two cervical vertebrae, tibial aplasia, and curved fibulae. Mental age was four years nine months.

The role of hereditary and developmental factors in cases with multiple malformations is discussed. Endocrinopathies are often present, probably in connection with faulty hypothalamic development. Although there are many variations, cases of this type are probably best classified as gargoylism.—*Charles Nice, M.D.*

Mazet, Robert, Jr., and Cozen, Lewis. The diagnostic value of vertebral body needle biopsy. *Ann. Surg.*, Feb., 1952, *135*, 245–252.

This is a report on 33 needle biopsies performed on vertebrae—2 in the cervical region, 1 on D1, 1 on D4, 1 on D11, 27 in the lumbar, and 1 in the sacral area. A positive diagnosis was made in 17 cases. In 9 other cases malignancy was discarded as a possilbe diagnosis as a result of the biopsy. In 10 instances the tissue removed was of no diagnostic value.

There were no complications as a result of the needle biopsy in any of the cases. The youngest patient was six years of age, and the oldest sixty-eight.

The technique of the procedure is outlined in detail, and the paper is well illustrated with diagrams, roentgenograms, and photomicrographs of biopsy specimens.—*E. A. Addington, M.D.*

Newman, P. H. Sprung back. *J. Bone & Joint Surg.*, Feb., 1952, *34-B*, 30–37.

Sprung back, according to the author, is one of the commonest causes of low back pain. It is caused by rupture of the posterior ligaments of the spine, including sometimes the posterior longitudinal ligament and annulus fibrosus. The onset may be associated with a fall or a blow on the back, a strain while lifting something heavy, childbirth, or violent activity during adolescence; but sometimes there is no idea as to the cause. The patient is usually a female. The ache is worse in certain positions, and in circumstances in which the lumbar spine is flexed and is either subjected to strain or is held in one position for a long time. Examples given are: (1) sitting in a slouching position with the lower part of the back unsupported; (2) lifting a weight at arm's length; (3) bending and stooping, especially with straight knees.

Active flexion of the lumbar spine may be slightly limited, but generally, like other movements, it is full. Straight leg raising may cause pain by rotating the pelvis but not by stretching the nerve roots. By lying on his stomach with three or four pillows beneath the abdomen, the patient can relax into a semiflexed position. This opens up the gap between the spinous processes and facilitates palpation of the supraspinous ligaments. Tenderness is found in the midline either at the space between the spinous processes of the fifth lumbar and first sacral segment, or between the fourth and fifth lumbar vertebrae. Frequently a depression, denoting damage or laxity of the supraspinous ligament, is felt at one of these interspaces and contrasts markedly with the resistance of the intact ligament at other levels.

Roentgen examination using the conventional anteroposterior, lateral and oblique views gives little help, but the lateral roentgenograms of the spine in full extension and full flexion may show mechanical instability.

In regard to disc prolapse, the author states that there are certain pointers which lead one to believe that the injury to the annulus fibrosus in these cases is caused by posterior separation of the two vertebrae, that the chronic weakness lies in all the structures binding the vertebrae together posteriorly, and that at least a great deal of the pain arises from

the supraspinous and interspinous ligaments. The following evidence suggests this: (1) Injury to the posterior part of the disc occurs most commonly at the same sites at which flexion injuries damage principally the posterior structures. (2) Friberg and Hirsch have shown by examination of 500 discs at necropsy that in the lower lumbar spine it is almost invariably the posterior arc of the disc which is damaged, and this suggests that the injuring force separates the vertebrae posteriorly. If injury to the annulus were due to compression, torsion or grinding, the damage would not be confined to the posterior quadrant. (3) In Newman's experience of operations for prolapsed disc, a torn or inefficient supraspinous ligament, and an unstable vertebra, are almost constant findings. (4) In cases of disc prolapse the supraspinous ligament is tender and deficient on palpation. (5) Chronic backache and attacks of acute lumbago frequently precede sciatica. (6) Kellgren showed that pain of a constant distribution could be produced by injecting hypertonic saline into the supraspinous and interspinous ligaments.

Assuming that separation of the vertebrae has been sufficient to injure the annulus fibrosus, Newman thinks it is easy to understand how chronic backache and recurrent lumbago over a period of years can be converted suddenly to an attack of acute sciatica with change of the clinical picture from one of moderate annoyance to that of an acute and incapacitating illness. The physical signs are altered by impingement of the prolapsed material on a nerve root. Lumbar spasm in flexion is as characteristic of disc protrusion as is spasm in extension of low back instability. The pain, formerly of scleratome distribution and relievable by an injection of procaine, now has a dermatome distribution and cannot be so relieved. A patient with a sprung back no longer has the ligamentous control necessary to prevent excessive flexion of the spinal column. A sudden movement rather than a deliberate controlled movement is more likely to cause an acute attack.—*Ralph S. Bromer, M.D.*

Gardner, W. James, Wise, Robert E., Huges, C. Robert, O'Connell, F. B., Jr., and Weiford, E. C. X-ray visualization of the intervertebral disk; with a consideration of the morbidity of disk puncture. *A.M.A. Arch. Surg.*, March, 1952, *64*, 355–364.

The authors report 169 cases of visualization of the intervertebral disc utilizing a modification of the technique originated by Lindblom. A 21-gauge needle (replacing an 18-gauge) was used for the initial lumbar puncture and a 26-gauge (replacing a 22-gauge) needle was passed through this for the actual disc puncture. One-half to 2.0 cc. of iodopyracet (35 per cent diodrast) was used as the contrast medium.

The central bilocular appearance in the presence of a normal disc; the irregular elongated changes indicative of a degenerated disc; and the irregular distribution combined with contrast medium bulging into the spinal canal beneath the posterior spinal ligament, due to protrusion of the disc, are discussed and illustrated.

Injection of the normal and degenerated discs was usually painless and made against resistance. Injection of a herniated disc encountered less resistance, and in two-thrids of the proved cases of protruded discs reproduced the patients' sciatic pain. Pain and contrast medium beneath the posterior spinal ligament without other roentgenographic evidence of a diseased disc were considered insignificant. In a diseased disc the contrast medium often disappeared within minutes, but remained in a normal disc up to twelve hours.

The authors believe that in 15 per cent of the 54 discs surgically explored false positive diagnoses were made, because they concluded that the protrusions found at operation were not sufficient to explain the patients' symptoms. All cases that had demonstrable narrowed interspaces on plain roentgenograms had either degenerated or herniated discs.

One case of septic necrosis of the disc, due to *Staphyloccus albus*, developed following the procedure. The authors review other reported instances of pathological disc changes following regular lumbar puncture and believe that such changes are most often due to infection introduced into the disc by the needle.

The reported disadvantages of this procedure are the possible morbidity, care and experience necessary for the injection, and the possibility of overlooking a tumor of the cauda equina. No bleeding was encountered.—*Robert L. Raphael, M.D.*

Young, H. Herman. Non-neurological lesions simulating protruded intervertebral disk. *J.A.M.A.*, March 29, 1952, *148*, 1101–1105.

In attempting to solve the problem of idiopathic back pain, the author believes that other lesions must also be taken into consideration besides the lumbago and sacroiliac strain which were popular formerly, and the omnipresent intervertebral disc protrusion of this area. Undoubtedly, some cases of low back pain with sciatica do represent protruded intervertebral discs, but the author goes on to add a word of caution in making such a diagnosis in all cases with similar symptoms.

Case reports are presented of osteoid osteomas, glomus tumors of the peroneal nerve, twisted ovarian cyst, myeloma of the first lumbar vertebra and eosinophilic granuloma of the ilium, the majority of which had symptoms similar to those produced by a protruded intervertebral disc.

In all the cases presented, a protruded disc was

believed, at one time or another, to be the cause of the symptoms. None had this finding. The correct diagnosis was made by use of contrast myelography in some cases, and in others, only after the operation performed for assumed disc protrusion failed to bring about relief of symptoms.

The author feels that although recently considerable progress has been made in the accuracy of diagnosis of the protrusion of intervertebral discs, careful history taking, physical examination and use of laboratory procedures should not be neglected.—*Lawrence R. James, M.D.*

Schrader, Ernst August. Die Rolle des Bandscheibenprolapses in der Pathogenese der zur Obliteration führenden arteriellen Erkrankungen. (The role of the disc prolapse in the pathogenesis of the diseases leading to arterial obliteration.) *Deutsche med. Wchnschr.*, March, 1952, *77*, 357–363.

In 1948, the author observed a patient in his clinic who had been suffering from intermittent claudication on the left side for two years. His past history brought out that the disease had had its inception at the time of a neurologic diagnosis of a prolapsed disc on the side which had given rise to sciatica. Through this observation he brought forth a suggestion that there was probably some relationship between the spinal abnormality and the obliterative disease of the arteries.

In 1949, 6 such cases were reported, and in 1950, 2 additional cases. In the present article 7 others are described.

The patients were studied by arteriography as well as conventional roentgenography of the spine. All the patients suffered from sciatica and symptoms of an obliterative arterial disease.

The author discusses the probable pathologic relationship between the two conditions. Two theories are advanced. The first postulates that the trophic disturbance is an immediate cause for the the arterial obliteration. This change can occur in the arterial wall in a manner similar to that observed in other known trophic disturbances in different locations accompanying neurologic processes. It is known that tissue damage leads to indolent ulcers, bone atrophy, and arthropathies. It is reasonable to suppose that the same trophic disturbances may occur in the wall of the vessels as well. Bezversenko has observed these changes in the dog experimentally by cutting peripheral nerves of an extremity. Histologic changes took place in the artery in the same extremity in fourteen days, followed by gangrene of the paw. He called the experimental disease "endarteriitis neurotica." Other experimental work is cited to support the theory, and the author finally concludes that the mechanism is as follows: An irritation is produced of the nerve tissue through the pressure of the prolapsed disc. This gives rise to nerve stimulation with change in the blood flow through the arteries, leading to altered circulation with consequent changes in the metabolism of the tissue which in turn produces trophic changes in the arterial wall.

The second theory suggests that the local effect of the pressure on the nerve elements in the spine is superimposed on pre-existing arterial disease—a summation effect.—*Paul C. Swenson, M.D.*

Wright, P. R., and Gardner, A. M. N. Traumatic chylothorax; a case after dislocation of the thoracic spine. *J. Bone & Joint Surg.*, Feb., 1952, *34-B*, 64–67.

In earlier years crushing injuries of the chest and stab and bullet wounds were responsible for most of the thoracic duct injuries. More recently many have occurred during intrathoracic operations. In the case reported in this paper, a bilateral traumatic chylothorax occurred after complete dislocation of the thoracic spine. The anterior surface of the body of the sixth thoracic vertebra lay almost in line with the posterior border of the body of the seventh, as shown in the roentgenograms.

Three to four days usually elapse after injury before the onset of symptoms of chylothorax. Of special interest in this case was the type of dislocation and secondly the fact that the pleura on both sides must have been torn at the time of injury, permitting protrusion of the intervertebral disc material into both pleural cavities. It was therefore possible for lymph to enter the pleural cavities from the beginning. Nevertheless, a roentgenogram forty-eight hours after the injury showed so little intrapleural fluid that chyle formation must have been greatly restricted during this period. There was the usual delay between injury and the onset of symptoms which cannot be explained by the usual accumulation of lymph in the mediastinum. During the first four days hemoconcentration must have occurred, the intake of fluid and food by mouth was restricted severely and it seems probable that lymph formation was correspondingly reduced; on the fifth day, however, improvement of the patient's general condition allowed an intake approaching normal and the rate of lymph production increased to normal. The pleural effusions now accumulated rapidly and caused pulmonary collapse with a consequent rise in venous pressure. This in turn, with anoxia after the collapse, caused a further increase in lymph flow leading to fatal respiratory obstruction.

The authors suggest that frequent examinations to exclude pleural effusion after crushing injuries of the chest and injuries of the thoracic spine may result in diagnosis before the onset of pressure symptoms.—*Ralph S. Bromer, M.D.*

Poppen, James L., and King, Arthur B. Chordoma; experience with thirteen cases. *J. Neurosurg.*, March, 1952, *9*, 139–163.

The authors report 13 cases of chordoma in detail with a clinical summary of each case, 7 with intracranial and 6 with vertebral involvement.

The tumors are characterized by their lack of a capsule and their infiltrating capacity. The dura and bone are readily invaded. The roentgen appearance is not typical; in most instances a diagnosis of metastatic malignancy was made.

Chordoma can rarely be removed by surgery; however, considerable palliation was obtained in several patients, with 1 apparent cure. These tumors do not metastasize readily, although occasional metastases will be found.

Roentgen therapy should be used with a maximum dose as a palliative procedure. The tumors may be quite cellular on microscopic study and yet show only minimal response to roentgen therapy.

Several roentgenograms and photomicrographs are included in the article and in addition a number of references are listed.—*Vernon L. Peterson, M.D.*

Brecke, Fritz. Schichtaufnahmen bei Wirbeltuberkulose. (Laminagraphy in tuberculosis of the spine.) *Tuberkulosearzt*, March, 1952, *6*, 171–173.

This method should be used: (1) for early diagnosis of tuberculosis of the vertebrae, in cases where the ordinary roentgenogram does not show any changes; (2) when important therapeutic decisions have to be made; (3) to determine the success of therapy and when to allow weight bearing.

With laminagraphy cavities smaller than a cherry may be shown when ordinary roentgenograms only show narrowing of the intervertebral space.—*Frederick M. Reis, M.D.*

Blood and Lymph System

Johnstone, Alan S. The visualization of the abdominal aorta and its branches. *J. Faculty of Radiologists*, April, 1952, *3*, 231–239.

Serial roentgenograms are essential to abdominal aortography if the fullest information is to be obtained. This paper is based on the analysis of serial films taken during abdominal aortography with the Ormerod automatic cassette changer. This apparatus is loaded with eight 10×12 inch cassettes and these are automatically exposed and changed at a speed of 1.25 seconds each, the complete series taking an overall time of ten seconds. The aorta remains outlined for three to four seconds, corresponding to the time taken for injection. The subsequent distribution of the medium depends on the level of the injection, the direction of the flow, and the anatomical variations of the arteries. After injection the medium becomes concentrated in viscera with large capillary beds, especially those of excretory function, increasing their density and thus making them more clearly defined on the film.

In the nephrogram with adequate concentration, the cortical and medullary segments can be defined and much information obtained about the functioning tissue. The spleen, liver and intestines may also be visible after injection. The suprarenal glands can be detected by virtue of their arterial distribution, but the arterial filling is not always complete.

It is obvious that after a sudden flooding of the arterial system and capillaries much of the medium must find its way into the veins. The splenic, portal and left renal veins have been identified roentgenologically. The author believes that this method of abdominal venography is still in its preliminary stages and that more accurate methods of venographic study by this means may be found.

Apart from renal conditions, abdominal aortography has definite value in the investigation of arterial disease, affecting particularly the lower extremities. In Leriche's syndrome with thrombosis at the origin of the common iliac arteries, one may obtain a clear picture of the circulation. A case of a forty-two year old male is cited, the individual complaining of intermittent claudication, severe in the right calf, and occasionally in the right thigh and left calf. The left femoral pulse was just palpable but no other pulsation was found in either lower extremity. The second film of the series showed filling of the abdominal aorta and a complete block at the right common iliac artery.

The author believes that in the study of circulatory disorders affecting the lower extremities serial examinations should assist in assessing the circulation time and that the method may permit a better study and understanding of the collateral vessels.—*Samuel G. Henderson, M.D.*

Moore, H. D. The visualization of the abdominal aorta and its branches. *J. Faculty of Radiologists*, April, 1952, *3*, 240–247.

The author's preferred method of injecting the radiopaque substance is by direct puncture of the aorta through the back. This consists of inserting the needle in the back four finger-breadths to the left of the midline and directing it upwards and inwards first to strike the vertebral body as a landmark and then to pass just in front of it to enter the aorta at the desired level—the level being at the upper border of D-12 for the celiac axis, superior mesenteric artery, and the renal vessels, and at L-2 for the inferior mesenteric, iliac and femoral arteries. The material must be injected rapidly, aiming at 20 cc. in two seconds. The author relies on a simple syringe and manual injection, employing a needle the diameter of which is 1.45 to 1.65 mm., using 20 cc. of 70 per cent iodine contrast medium to outline the arteries and 30 to 40 cc. if venous filling is also desired.

The risks to be considered are: (1) possible damage to abdominal organs while inserting the needle, (2) damage to the aorta itself, (3) danger from the substances injected. The puncture of the aorta causes no ill effects—the author having seen several of these cases at operation within a day or two of the puncture, at which time the aorta looked normal without extravasation around it. The opaque medium preferred by Moore is diodone. He advises the use of 1 cc. of this medium intravenously to test for sensitivity in patients who have not already had an intravenous urogram. The needle, if inserted as above described, does not strike any abdominal organ.

The author takes a preliminary roentgenogram with small lead markers on the back to estimate the exact vertebral level. Difficulty in entering the aorta is almost always due to the use of too short a needle. A needle 4½ inches in length is sufficient for a child or thin woman, but a 5 inch needle is necessary for a thick set individual. Other difficulties which may arise include entering a vein and mistaking it for the aorta, and injecting part or all of the medium outside the aorta. This latter accident leads to no ill effect other than a good deal of pain for some hours.

The level of the main arteries in the normal patient is given as follows: celiac axis—upper border of the 12th thoracic vertebra; superior mesenteric artery—center of the 12th thoracic vertebra; renal vessels—center of 1st lumbar vertebra; inferior mesenteric artery—upper border of 3rd lumbar vertebra; aorta branches—4th lumbar vertebra. The direction of hepatic, splenic and renal arteries is at right angles to the aorta, while the superior mesenteric artery is usually in line with or just to the left of the aorta and therefore difficult to see.

The examination of the kidney is particularly useful, especially from the standpoint of possible congenital anomalies, hydronephrosis, tumors and sclerosis of the vessels. In hydronephrosis an aortogram may show the cause, such, for example, as an aberrant vessel, or it may give valuable evidence of the functional state of the kidney by the size of the vessels supplying it and by the density of the "renogram." The comparative density of the kidney shadow is chiefly of value where the kidney substance has become stretched and atrophied over a hydronephrotic sac. Hypernephroma of the kidney presents as a distortion of the vessels with a variable area of normal kidney shadow with an area where diodone has collected, but not diffusely and evenly, in what has been described as "puddling." Cysts of the kidney being avascular give an entirely different appearance, the distortion of the vessels being the primary object, together with an area or areas where there is no contrast medium. In sclerosis of the kidney in hypertension the aortogram may provide the only evidence of the cause of recurrent pain in the renal area, in a patient in whom excretory and retrograde urographic studies are normal.

Several excellent illustrative roentgenograms are shown in connection with this article.—*Samuel G. Henderson, M.D.*

Dreyer, B., and Budtz-Olsen, O. E. Splenic venography; demonstration of the portal circulation with diodone. *Lancet*, March 15, 1952, *1*, 530–531.

A method is described for the visual demonstration of the splenic and part of the portal circulation by the injection of radiopaque material into the spleen without laparotomy. A small lumbar puncture needle is used, and 20 cc. of 70 per cent diodone is injected through the ninth intercostal space into the spleen. The roentgen-ray exposure is made toward the end, but before the completion, of the injection.

This procedure has now been used in 11 patients without untoward incident. A case record of 1 of these is presented, in whom splenic venography demonstrated complete obstruction of the splenic vein, with the radiopaque material reaching the portal vein via anastomosing gastric veins.—*Douglas S. Kellogg, M.D.*

Nelson, Russell A., and Stofer, Bert E. Acute reticuloendotheliosis (Letterer-Siwe disease); report of a case in which several unusual features are combined. *A.M.A. Am. J. Dis. Child.*, April, 1952, *83*, 475–480.

The case reported by the authors is believed by them to support the idea of Wallgren and others that the whole group of endothelial diseases represents varying degrees of pathologic change in the reticuloendothelial system.

The authors quote Abt and Denenholz who described the following characteristics of Letterer-Siwe disease: (1) hepatosplenomegaly; (2) hemorrhagic diathesis, especially petechiae and purpura; (3) generalized lymphadenopathy of a mild to moderate degree; (4) progressive anemia with a usually normal leukocyte count; (5) nonhereditary, nonfamilial occurrence, exclusively in infants and young children, with unknown etiology, fatal prognosis and variable duration (from a few weeks to several years); (6) localized skeletal tumors; (7) generalized hyperplasia of the reticuloendothelial cells with focal tumorous proliferations, especially in the spleen, liver, lymph nodes, thymus, skin, and bone marrow, often showing a hemorrhagic tendency, but no lipid storage. Abt and Denenholz felt this was a clinical entity, but Wallgren thought that basically this is the same granulomatous process which goes on to lipid storage in the macrophages if the disease continues over a long enough period.

Their own case, the authors state, fills most of the criteria as described by Abt and Denenholz. Bone tumors were not grossly or roentgenologically demonstrable but the microscopic examination disclosed that lesions of mixed type were present in the marrow. At autopsy, there was evidence of emphy-

sema in the lungs, the mediastinum and subcutaneous tissues of the neck and anterior chest. The autopsy also revealed pulmonary cysts with the emphysema and resultant pulmonary atelectasis. The patient died before development of pneumothorax. Extension of the emphysema beyond the lungs is apparently a unique feature.—*Ralph S. Bromer, M.D.*

Wilkie, John. Radiology in peripheral arterial disease. *Proc. Roy. Soc. Med.*, March, 1952, *45*, 143–146.

This communication is based on a study of 142 cases of arterial disease in the lower limbs. These cases were distributed as follows: ateriosclerosis 87 cases, thrombo-angeitis 36 cases, unclassified 5 cases, and 14 cases showing no roentgenographic evidence of aterial disease.

Technique: Serial roentgenograms of the lower limb, from bifuraction of the common femoral artery to the foot, are obtained following a single injection of 20 cc. of diodone. Anteroposterior and lateral roentgenograms are made using two mobile roentgenographic units. The femoral artery is exposed under general anesthesia, and temporary hemostasis is obtained by using rubber bands on the artery.

Clinical aspects: Clinical manifestations of peripheral arterial disease include foot cramps, gangrene of toes, elevated skin temperature and color changes, and intermittent claudication. Efficacy of lumbar sympathectomy is measured by increased nutritional status of skin and toes, relief of pain and increased exercise tolerance.

Normal arteriogram: The main channels are characteristically smooth in outline. The profunda femoris branch tapers fairly rapidly giving off perforating branches. There is a minimum number of collateral branches and this helps to distinguish between normal and early arterial disease, for the opening of collateral branches may be the only indication of abnormality. The distal arteries gradually diminish in caliber to form a network of vascular loops in the foot. Temporary smooth narrowing of the lumen over several centimeters may occur as the result of spasm. A thread-like density may remain following the passage of the contrast medium and is considered entirely normal. The vessel caliber varies from individual to individual.

Abnormal arteriogram: Abnormality is indicated by alterations in contour, thrombosis and diminution in arterial caliber, abnormal size or number of collateral channels and the absence of venous filling. The presence or absence of arterial thrombosis is sometimes difficult to demonstrate below the knee due to inadequate filling. Venous filling is unusual in established arterial disease. Good arteriograms will show the position and extent of a thrombosis, the number and size of collateral branches and whether or not there is filling of a large number of vascular loops in the foot.

The site and extent of thrombosis are recorded in each case. The collateral circulation and the filling of vessels in leg and foot are reported as good or poor.

When amputation is considered on the basis of gangrene, arteriography is of little or no help in deciding the need or level of amputation. There is no direct relationship between the size and number of collateral channels and the adequacy of collateral circulation. Circulation can be considered adequate on the basis of arteriography only when well filled veins are visualized at the knee and above (in the absence of arteriovenous fistulae).

Arteriography performed after lumbar sympathectomy proved of little value.—*Donald R. Berhardt, M.D.*

Lemaire, A., Loeper, J., Tubiana, M., Bonniot de Ruisselet, R., and Pierquin, B. L'exploration de la circulation sanguine dans le secteur rate-veine splénique-foie. (Exploration of the blood circulation in the spleen–splenic vein-liver area.) *Presse méd.*, March 15, 1952, *60*, 349–350.

Injection of radiopaque, colored and radioactive substances directly into the spleen was made. Only patients with an enlarged spleen below the costal margin were selected and in whom the blood studies were normal.

The authors employed diodone as the radiopaque substance which was injected transparietally. In the rat, only the spleen was opacified; the splenic and portal veins were not visualized. In the human, the method was unsuccessful and the injection was associated with considerable pain.

Colored substances gave more success. Rapid injection into the spleen of 5 cc. of 1 per cent congo red was followed by sampling from a neck vein, 0, 1, 2, 3 and 5 minutes later. These samples were examined electrophotometrically. The values are not absolute but can be compared relatively. The results fell into three groups: (1) very rapid passage seemed to be found in moderate and recent splenomegaly; (2) slower but definite passage occurred in more marked splenomegaly with fibrosis present for several months; (3) complete lack of passage occurred only in a case diagnosed as splenic vein thrombosis.

The radioactive substance was used as follows: A Geiger counter was positioned over the spleen and one over the liver; 2 cc. of isotonic sodium iodide corresponding to 1 mc. radioactive iodine was injected transparietally. In all cases except one, radioactivity was registered over the liver during the two second injection. The exception was with splenic vein thrombosis.—*Marcy L. Sussman, M.D.*

General

Bouslog, John S. The country radiologist. *Radiology*, April, 1952, *58*, 556–559.

This is the Presidential Address presented by Dr. John S. Bouslog of Denver, Colorado to the

Thirty-seventh Annual Meeting of the Radiological Society of North America, Chicago, Illinois. In this presentation, the author likens the country or general radiologist to the old-fashioned country doctor or general practitioner as compared to the radiologist in a great metropolitan center, and states that he acquires responsibilities far beyond those of the radiologist in the large city. The general radiologist must never forget that he is primarily a physician and that he is dealing in most cases with people who are ill and who need gentleness and care. He should keep constant contact with the clinicians and recognize their problems and points of view. He should train himself in a technical aspect so that he can handle the simpler problems that come up in the mechanics of his practice.

The author stresses the personal contact between the radiologist and patient which should be maintained through the periods of diagnosis, treatment, after-care and follow-ups. The use of radioactive isotopes both as tracers and for therapy should be familiar to the radiologist. Since the radiologist is trained to know the biologic effects of radiation, he should be willing to serve his community by indoctrinating the public in civil defense problems as posed by atomic warfare.

Lastly, the radiologist must keep abreast of advances in all fields of medicine as he, in the rural areas, may be the one to evaluate what is to be accomplished by irradiation or surgery and therefore to decide on the best method of treatment. He should learn to do well what he can do and to leave the special fields to the specialists in the cities where they can safely limit themselves.—*Donald N. Dysart, M.D.*

Wheeler, Clayton E., Curtis, Arthur C., Cawley, Edward P., Grekin, Robert H., and Zheutlin, Bertram. Soft tissue calcification, with special reference to its occurrence in the "collagen diseases." *Ann. Int. Med.*, April, 1952, *36*, 1050–1075.

The article deals with the abnormal deposition of lime salts in tissue, or calcinosis.

The factors influencing calcification are discussed. Anything which upsets the interrelation between calcium and phosphorus or the tissue fluid or serum acting as a solvent may cause deposition of insolubie calcium phosphate, if the change interferes with their solubility.

There seem to be two main types of pathologic calcification. (1) In the presence of tissue injury, changes occur favoring this. They may involve the mechanism that injured tissue serves as a substrate for a phosphorus releasing enzyme, and it may also develop a lowered carbon dioxide tension, so that fewer ions can be held in solution. (2) The other type includes metabolic abnormalities causing increase in the concentration of calcium or phosphorus, or both. This would include hyperparathyroidism, pseudohyperparathyroidism, renal insufficiency, vitamin D intoxication, and destructive bone lesions.

The terms, calcinosis circumscripta and calcinosis universalis, refer to the deposition of lime salts either in one place or generally throughout the body.

Sixty-six cases of "collagen diseases" showing local or general manifestations comprised chiefly of cases of scleroderma dermatomyositis are analyzed in detail as regards blood chemistry and roentgen findings. The authors point out that this is using a descriptive term in place of a diagnostic term, and may discourage further investigation of a case. They followed up many cases reported as one of these and found that a distinct diagnosis could be made in almost all of them. Especially prominent were dermatomyositis and scleroderma, but numerous others were found.

The authors state that pathologic soft tissue calcification should be investigated carefully, since in some cases specific treatment may prove of definite value. They show that many cases diagnosed as calcinosis circumscripta or universalis may be merely part of an underlying collagen disease.—*George L. Sackett, Jr., M.D.*

Pack, George T., and Ariel, Irving M. Fibrosarcoma of the soft somatic tissues; a clinical and pathologic study. *Surgery*, March, 1952, *31*, 443–478.

The authors studied 39 cases of undisputed fibrosarcoma of the extremities and torso seen at Memorial Cancer Center from 1931 to 1948 inclusive. From their studies, trauma has not been shown to be the sole etiologic agent in any cases. In 2 cases fibrosarcoma developed in scar tissue. Heavily irradiated areas have occasionally been the sites of fibrosarcomas. They mention a reported case of fibrosarcoma of intrauterine development, and report a similar case in which the patient was an infant six weeks of age. Average age of their patients was thirty-nine years.

The extremities are the most common site of fibrosarcomas, but this tumor also occurs in such unusual sites as the liver, lungs and central nervous system.

The symptoms are not characteristic, but the tumor usually starts as a painless, slow-growing mass. On some occasions, a long period of inactivity is followed by rapid growth. The neoplasm may start rapidly and metastasize early. Average delay from onset of first symptom until establishment of diagnosis was thirty-two months. When first observed, the tumors in this group averaged between 4 and 7 cm. in diameter. They were not freely mobile, but the overlying skin could be moved with ease over the tumor.

The tumor usually arises from subcutaneous aponeuroses or intermuscular fibrous septa. The tumors

usually appear to be encapsulated, but shelling the capsule and tumor out of their bed is inadvisable as the tumor may have infiltrated through the capsule into contiguous structures. The general tendency of fibrosarcoma is to force itself against a contiguous structure rather than to infiltrate it. Injury of an area of skin where a large subcutaneous tumor is situated may result in fungation.

Metastasis to the lungs occurred in 21 per cent of the authors' series of cases. This is in contrast to a much higher percentage in cases of other sarcomas of soft tissues (synovial sarcoma, 65 per cent; rhabdomyosarcoma, 39 per cent). Metastasis usually occurs by the blood stream, but the lesion may metastasize to the regional lymph nodes.

In 56 per cent of the cases reported in this review, the tumor recurred at an average of 8.6 months following treatment. Prognosis following treatment appears to be poorest in the third and fourth decades.

As regards therapy, the authors stress the futility of inadequate operation, the usual ineffectiveness of roentgen therapy, and the prognostic significance of microscopic structure.

Of 22 patients treated more than five years ago, 59 per cent were alive without recurrence.

Alexander is cited to the effect that the best results obtained in the surgical treatment of solitary metastatic neoplasm to the lungs, by pulmonary resection, are in cases of metastatic fibrosarcoma.—*André Bruwer, M.D.*

Taylor, J. Duncan. Post-mortem diagnosis of air embolism by radiography. *Brit. M. J.*, April 26, 1952, *1*, 890–893.

The difficulty in proving air embolism at autopsy is caused by the rapid appearance of gas producing organisms after death (1 to 4 hours) and the ease with which air is introduced into viscera by handling. The former must be ruled out by blood cultures and the latter prevented by ligating all vessels before sectioning.

Roentgenograms of the pelvis following criminal abortion and ensuing death have been suggested to detect air emboli in the uterine plexus and pelvic veins. Postmortem stereoscopic roentgenograms of the skull have been reported to show air in cranial vessels in fatal arterial air embolism. The author suggests use of postmortem roentgenograms to make the diagnosis of air embolism and to indicate the dissection technique for the pathologist. These should be made within one hour of death.

Two cases are presented. One was a death occurring during the institution of pneumothorax therapy. The postmortem roentgenogram showed dappled densities in the left ventricle (probably froth), and air in the aorta, innominate artery, the common and internal carotid arteries and the right subclavian artery. No air was visible in the cranial vessels. Autopsy confirmed the roentgenograms but also showed air in the circulus arteriosus, abdominal aorta, coronary arteries and external iliac arteries. It was presumed that air entered the pulmonary venous system through a puncture in the left lung.

The other case was a death occurring during the refill of a pneumoperitoneum. Postmortem roentgenograms showed air in the right auricle, the pulmonary artery and its branches, the splenic vein, the intrahepatic vessels, the left hepatic vein and questionably the portal vein. Autopsy confirmed the presence of this air plus air in the inferior vena cava, common iliac veins, internal mammary veins and external jugular veins. Air apparently entered through a splenic puncture.

Roentgenograms are shown and a discussion of pathogenesis is given.—*Henry J. Klos, M.D.*

Olstad, Robert B., and Lord, Robert M. Kerosene intoxication. *A.M.A. Am. J. Dis. Child.*, April, 1952, *83*, 446–453.

This paper is a study of 71 cases of kerosene ingestion in children. Various types of treatment are analyzed. Histories were examined to ascertain the following data: time elapsed prior to hospitalization, estimated amount ingested, place obtained, and whether or not vomiting occurred. The month and the year of admission and the age of the patient were recorded. The following clinical aspects were studied: symptoms and signs, classified according to involvement of respiratory, gastrointestinal and central nervous systems; fever; genitourinary findings and length of hospitalization.

Forty-four patients had roentgenograms of the chest and 26 (or 59.1 per cent) had positive evidence of pneumonia in the roentgenograms; 29 patients (or 40.8 per cent of the total) were considered to have a pneumonic process. The roentgenographically demonstrable lesions in all cases were in the lower lobes. In 13 cases both lower lobes were involved. In 19 cases with positive roentgenographic findings no positive auscultatory findings were reported.

A large majority of cases were the result of accidental ingestion of kerosene by infants and children exposed to kerosene in easily accessible places in the family drinking utensils, which were usually used because of a defective stove. In 22 cases, kerosene was available in a drinking utensil on the floor.

On the basis of their experience, the authors feel that treatment should consist primarily in the removal of the kerosene from the gastrointestinal tract as quickly and completely as possible. This can be accomplished most adequately with the use of a stomach tube and copious amounts of water or saline. High colonic irrigations and saline cathartics are also recommended. A plea is made to educate families with kerosene stoves as to their potential dangers and it is suggested that perhaps manufacturers could relocate the fuel oil reservoir air vent in a less accessible place. A leaking stove or air vent was responsible for 23 cases.—*Ralph S. Bromer, M.D.*

Gershon-Cohen, J., Hermel, M. B., Read, H. S., Caplan, Bernard, and Cooley, A. G. Telognosis; three years of experience with diagnosis by telephone-transmitted roentgenograms. *J.A.M.A.*, March 1, 1952, *148*, 731–732.

Following the initial trial of this system in 1947, a circuit was established over busy commercial telephone channels between the Ventnor Clinic in Atlantic City, N. J., and Philadelphia, a distance of 60 miles.

The apparatus consists of a transmitter that scans roentgenograms of any size up to 14 by 17 inches. The receiver reproduces facsimiles reduced to half the size of the original films. Consultations and reports of the roentgen findings are made over the same telephone circuit employed for sending the facsimiles. The facsimile photographic film (Eastman type C) is inexpensive, coasting an average of less than 4 cents per copy.

Interpretation of the facsimile was found to be extremely accurate when compared with the original film. Lack of fluoroscopy was compensated for by extra films. Hospitals with competent radiologists would not find the method practical. It could be used as a means of teaching residents and fellows in radiology who are serving in small hospitals as a part of their training period by giving them expert consultation. It could also furnish full-time roentgenologic interpretation to the small hospital unable to secure the services of a radiologist.—*Arthur B. Smith, M.D.*

Brailsford, James F. Factors which influence the value of a radiological investigation. *Lancet*, April 5, 1952, *1*, 679–683.

Under the National Health Service, roentgenological investigations have increased both in number and in complexity. Anticipating further increase with the added expense of materials, equipment, technicians, nurses and doctors, the author calls upon the medical profession to help regulate the economy so that the hospital system will not become unbalanced.

The necessity for elimination of unnecessary roentgenographic examinations is stressed. Measures to accomplish this and also to make necessary roentgenography more valuable to the patient are discussed. Roentgenologic examination should not be considered a short-cut to diagnosis and should not be substituted for an adequate history and careful physical examination. It should be employed, not to satisfy a curiosity, but to furnish evidence helpful in the treatment of the patient that careful clinical examination has failed to reveal.

The limitations of roentgenology, such as the paucity of information obtained about soft tissue lesions, the latency of roentgenographic changes in inflammatory processes and the slow progress of certain conditions should be remembered. If this is done, many purposeless examinations may be avoided.

Proper preparation of the patient for the examination to be done, good roentgenographic technique, faultless processing of the films and the avoidance of many additional, non-informative special roentgenographic projections are additional factors which help to eliminate waste and increase the value of the roentgenological investigation.—*Gerald Lavner. M.D.*

Sherwin, Benjamin, and Gordimer, Harry. Kaposi's sarcoma; case report with unique visceral manifestations. *Ann. Surg.*, Jan., 1952, *135*, 118–123.

The authors present a case of Kaposi's sarcoma with an unusual visceral spread, with involvement of the mesentery of the small intestine, progressing to the formation of a large intra-abdominal air cyst, which was visualized on roentgenography. The case is that of a male, aged sixty-one, who initially presented himself with typical skin lesions of the upper and lower extremities which were treated successfully by roentgen therapy. Nine years after onset, following surgical treatment for skin lesions, he developed a mass in the abdomen which at roentgen examination appeared as a large circumscribed gaseous shadow with a fluid level in its dependent portion. An abdominal operation revealed the cyst to be attached to the mesentery of the small bowel and to contain fecal matter. Pathologically this was diagnosed as Kaposi's sarcoma of the mesentery. The patient subsequently developed other abdominal metastases and at the last exploratory operation exhibited multiple thin-walled cysts which contained necrotic tissue and gas.

A brief résumé of the clinical picture of Kaposi's disease is given, including age, race, life expectancy, distribution and appearance. Two theories as to etiology are discussed, one that it arises from the reticulo-endothelial system, the other that it originates from the fibroblast, although most observers agree that the disease is malignant.

Histological and gross specimens are demonstrated with one roentgenogram showing the large cyst.—*Leslie L. Lemak, M.D.*

RADIATION THERAPY

Oppenheimer, Gordon D., Narins, Lester, and Simon, Norman. Radiotherapy in the treatment of nonspecific inflammatory stricture of the ureter. *J. Urol.*, April, 1952, *67*, 476–478.

This case report concerns a fifty-seven year old white male whose chief complaint was pain in the

right pubic region. Careful studies showed a right hydronephrosis and hydroureter with a stricture of the ureter just above the bladder. Biopsy of the mass surrounding the ureter and of the ureter itself showed no evidence of tumor. The blood picture and the bone marrow were normal. The ureter continued to drain for approximately seven weeks following operation, but the fistula eventually closed spontaneously. Following this, the patient's symptoms continued and the hydronephrosis on the right side persisted. Further studies again showed a stricture of the right lower ureter and the patient was then treated by radiation therapy consisting of a calculated tumor dose of 560 r. Prompt relief of pain followed this treatment. The urine became clear, and the intravenous urogram showed an almost complete disappearance of the right hydronephrosis.

This case illustrates very well the efficiency of radiation therapy in the treatment of some chronic granulomatous infections.—*George W. Chamberlin, M.D.*

Macchi, Livio. Contributo allo studio del trattamento degli epiteliomi della tonsilla e delle loro adenopatie con la sola roentgenterapia. (Contribution to the study of the treatment of epitheliomas of the tonsil and their adenopathies by roentgen therapy alone.) *Radiol. med.*, March, 1952, *38*, 247–261.

The author gives a statistical analysis of the results in 124 cases of carcinoma of the tonsil treated from 1940 to 1949 at the Fondation Curie, Paris, by roentgen therapy alone.

Clinically, the carcinoma was classified, by following the suggestion of Baclesse, into three stages: Stage I, lesion localized to the tonsil; Stage II, lesion involving the tonsil and one of the two pillars; Stage II, advanced, lesion involving the tonsil and both pillars; Stage III, extension either to the palate, or to the base of the tongue or to the glossotonsillar sulcus and beyond; Stage III, advanced, simultaneous extension either to the palate and base of the tongue or to the palate and the glossotonsillar sulcus.

Histopathologically, a distinction was made between (1) undifferentiated carcinoma, (2) intermediary carcinoma, (3) differentiated epidermoid carcinoma of the cutaneous type and (4) differentiated epidermoid carcinoma of the mucosal type.

In 73 per cent of all cases metastases to the lymph nodes were already present at the time of institution of roentgen therapy. In 20 per cent the lymph node metastases constituted the first manifestation of the disease.

Of 105 patients treated between 1940 and 1947 inclusive, 17 (16 per cent) were locally cured three years after treatment; and of 81 patients treated between 1940 and 1945 inclusive, 13 (16 per cent) were cured five years after treatment. The author gives several tables expressing the relationship of these results to the clinical stage of the disease, the histopathologic grade of differentiation, the tumor dose, and the duration of the treatment.

The presented figures indicate that the primary carcinoma of the tonsil as well as the metastases to the lymph nodes requires progressively larger doses as their size and extent increase. From the histopathologic viewpoint, the undifferentiated and intermediary types are more radiosensitive than the highly differentiated types. Both the primary lesion and regional metastases show the same irradiation response when identical doses are administered. Of 91 patients with extension to one or both sides of the neck, 50 per cent showed a complete disappearance of the metastases, lasting for at least six months.

Roentgen therapy was carried out with the following factors: 180 kv., 1 mm. Cu plus 2 mm. Al, and, less frequently, 250 kv., 1 mm. Cu plus 2 mm. Al or 500 kv., 6 mm. steel; 4 to 15 ma.; 15 to 20 r/min.; and 50 to 60 cm. skin-target distance. For the treatment of the primary carcinoma of the tonsil two contralateral facial fields were used. In case of unilateral cervical metastasis one or two more fields were added for the neck on the affected side (superior cervical and inferior cervical fields); and if there was evidence of bilateral cervical metastases, one or two more similar fields were added for the other side of the neck as well. All fields were usually 6 by 7 cm. in size, but after the administration of a surface dose of 4,000 r they were gradually reduced, due care being taken that the central ray was always directed to the site of the active focus. Daily doses of 200 r were administered alternately over each set of fields for a total of 600 r per field a week.

The best results were obtained when the irradiation was continued without interruption over a period of seventy to eighty days for a total tumor dose of 7,000 r on the primary lesion as well as on the metastatic lymph nodes. This dose may be reduced to 6,500 r in the undifferentiated and localized types of carcinomas. If the reaction after the fourth to sixth week becomes too severe it may be necessary to reduce the daily dose or even suspend the treatment for a short interval to allow the tissues to recover, enabling the protraction of the irradiation over the contemplated period. Occasionally an intraoral field was also used, in which case two to six doses of 200 r per week were given with the same physical factors, up to a total dose of 2,000 to 6,000 r. The field was 6 to 9 $cm.^2$ in size.

The author emphasizes that the above mentioned technique must be carried out meticulously by specially trained personnel to avoid possible damage from overirradiation or overlapping of fields. Late sequelae were observed in 13 of the 124 patients, consisting of telangiectasis (3), sclerosis (1), osteonecrosis (8), and cutaneous necrosis (1).—*T. Leucutia, M.D.*

Hellriegel, Werner. Zur Behandlung der malignen Melanome. (On the treatment of malignant melanomas.) *Strahlentherapie*, 1952, *86*, 548–564.

To contrast the results from treatment of malignant melanomas by operative procedures and post-operative irradiation with those from irradiation alone, 99 cases were followed and reinvestigated. Sixty-nine of these had some sort of surgical treatment (biopsy, excision, coagulation, cauterization, etc.) with an average post-treatment life of 2½ years. Thirty cases were treated by irradiation alone with an average post-treatment life of 6½ years.

Conclusions from this study are: Injury or surgical treatment of melanomas—even biopsy—must be avoided. Melanomas of the eyes and mucosa of the nose or paranasal sinuses have a much better prognosis than those of the external skin. The treatment of malignant melanomas is exclusively a radiation therapeutic problem. Even the melanomas with regional lymphatic metastases should receive vigorous radiation therapy.

The only remarks about treatment technique state that conservative use of irradiation will hardly allow a desirable result, and that in several irradiation series, 15,000–20,000 r must be delivered to the tumor. Permanent damage must be accepted as part of the price paid for adequate treatment of this highly malignant condition.—*Henry G. Moehring, M.D.*

Kahn, Reuben L., Hodges, Fred J., Lampe, Isadore, and Doyle, Owen W. Effect of irradiation on the universal reaction in cancer. *Cancer Research*, March, 1952, *12*, 170–175.

In recent publications Kahn expressed the opinion that the universal serologic reaction is an immunologic indicator of tissue break-down. This concept received considerable support through experimental observations, according to which animals subjected to irradiation developed definite changes in their universal reactions, due to tissue damage incident to the irradiation. At the suggestion of Dr. Shields Warren of the Atomic Energy Commission, the investigations were extended to human beings. The authors of the present article give a preliminary report of the results obtained before and after irradiation of cancer patients, since they appear to be of some clinical value.

The universal reaction is defined as a serologic precipitation reaction to lipids based on different NaCl concentrations and different periods of incubation. For its determination seven quantitative set-ups are used with steps similar to those employed in the conventional Kahn test, except for the different NaCl concentrations and incubation periods. The technical procedure is described in detail and examples of the precipitation results are illustrated graphically in the form of individual columns and interpolated curves.

The clinical study was carried out on 10 patients afflicted with various types of cancer. In each case two blood specimens were obtained, one before and in some instances during irradiation, and the other after irradiation. They were sent to the Serology Laboratory as "unknowns" and without any indication of the clinical status of the patient.

On classifying the universal reactions, it was found that, following irradiation, 5 patients showed increased precipitation, 2 showed reduced precipitation and 3 showed no change in precipitation as compared to the pre-irradiation reactions. By harmonizing these findings with the clinical response of the cancers to the irradiation, the authors arrived at the conclusion that (1) increased precipitation following irradiation signifies a normal post-irradiation course, indicating that break-down of the cancer tissue resulted in sufficient improvement of the patients to enable them to respond with increased antibody production of liberated lipids, whereas (2) reduced or unaltered precipitation following irradiation implies an abnormal post-irradiation course, indicating that the break-down of cancer tissue was unable to provoke increased antibody formation because of the poor status of the patient due either to cachexia or to widespread metastasis.

Obviously, further studies over a prolonged period of time are necessary before it will be possible to determine the value of this new serologic test to the clinician in interpreting the results of radiation therapy in cancer.—*T. Leucutia, M.D.*

Kahn, Reuben L., Bullock, William H., and Bethell, Frank H. Effect of irradiation on the universal reaction in polycythemia vera. *Cancer Research*, March, 1952, *12*, 176–179.

The clinical value of the aforementioned serologic test (see preceding abstract) was studied in collaboration with the staff members of the Simpson Memorial Institute in 12 patients afflicted with polycythemia vera.

The irradiation in this group of patients was carried out with P^{32}. Blood specimens were obtained before and within one to four months after the isotope therapy and sent to the Serology Laboratory as "unknowns." Graphic charts of the precipitation results are presented together with a brief summary of the clinical data in each case.

In correlating the universal reactions of the patients following irradiation with the clinical response the authors noted that: (1) in patients in whom the serologic test showed an increase in precipitation following P^{32} therapy, the polycythemia was found to be controlled, and (2) when there was no rise in precipitation following the irradiation the polycythemia was found to be in an active state and not under control.—*T. Leucutia, M.D.*

Bourdeau, Robert, and Laufman, Harold. Local hemostasis in the hemorrhagic syndrome of irradiation. *A.M.A. Arch. Surg.*, Feb., 1952, *64*, 154–158.

Laboratory experiments are reported in which 10 of 15 dogs, exposed to lethal doses (350 to 400 r) of whole body irradiation, developed within eight to eleven days hemorrhagic syndromes as shown by prolonged whole blood coagulation times. Six of the 10 dogs were operated on and sections of splenic tissue removed in each case. In spite of the induced coagulation defects, bleeding at the time of operation could be effectively controlled with gelatin sponge packing. All operated dogs, however, died within seventy-two hours after surgery, significantly sooner than one would expect from radiation effect alone and demonstrating that such animals do not tolerate surgery or anesthesia well.—*James Martin, M.D.*

Porter, Edward C. Relationship between the adrenal cortex and radiation sickness; a review of the literature and a presentation of new data. *Radiology*, Feb., 1952, *58*, 246–258.

The literature is reviewed with respect to correlation between adrenal cortical activity and radiation sickness. The author then follows the adrenal cortical activity of 36 patients undergoing long term roentgen therapy by means of daily eosinophil counts. In this small series, a greater than 50 per cent drop in eosinophil count was evident only following the onset of radiation sickness (10 patients, group 1). No significant drop occurred if there were no sickness (22 patients, group 2). When an initial low count was present (4 patients, group 3), radiation sickness occurred more readily and/or with greater severity.

As therapy continued on patients of the first group, there was a gradual rise in the eosinophil count, accompanied by lesser or no attacks of radiation sickness, with one exception. This patient had a persistently low count accompanied by recurrent radiation sickness similar to that shown by patients of group 3.

From the foregoing, it is suggested that the adaptation syndrome of Selye tends to guard against the "shock" of radiation therapy. It is assumed that the "shock" is due to protein breakdown products which in turn stimulate a greater production of adrenal corticoids. On this basis, the author suggests the use of cortisone in the prevention of repeated attacks of radiation sickness, if the expected result is borne out by work on experimental animals—*Martin B. Goodwin, M.D.*

Garcia, Manuel. The curability of carcinoma of the cervix in the Negro. *South. M. J.*, Feb., 1952, *45*, 145–152.

An analysis of 1,203 consecutive cases of carcinoma of the cervix, 66 per cent of whom were Negroes, is reported from the Charity Hospital of Louisiana at New Orleans.

Absolute five year survival rates after radiation therapy alone are given which indicate a significantly better prognosis among white women than among Negro women treated in the same institution. The difference in the two groups is apparently due to difference in social, economic and educational status rather than to a fundamental difference in disease evolution and radioresponsiveness. Negro women generally presented a higher incidence of advanced lesions with more instances of intercurrent infections and general poor health as a result of lower average levels of education and intelligence. Cooperation with the physician was frequently lacking and some Negro patients failed to complete the precribed courses of treatment or return subsequently for follow-up care. Analysis revealed a higher incidence of primary lesions in young Negro women presumably associated with the fact that child bearing begins with them at an earlier average age; and there were in this group tumors of a more malignant grade. Average life expectancy in the Negro is lower than in whites and death from other causes than cancer occurred more frequently thus affecting long-term absolute figures.

In spite of these factors, however, study of a subsequent group of 199 patients showing improved survival rates indicated that appreciable results can still be obtained when close attention and care are applied to the radiation techniques employed.—*James Martin. M.D.*

Randall, Clyde L., and Hall, Donald W. Results of the treatment of ovarian malignancies. *Am. J. Obst. & Gynec.*, March, 1952, *63*, 497–510.

This paper is written on the basis of material from the University of Buffalo and the Buffalo General Hospital but also includes a considerable amount of material gathered from the literature.

An analysis of the tumors responsible for death due to pelvic cancer reveals ovarian malignancies as a major and wholly unsolved problem. Five year survivals, as reported in the literature, show extreme variation from 65.4 per cent to 15.2 per cent. This is probably due to a difference in classification.

A recent review showed that 16.2 per cent of the women operated upon for ovarian tumors in the Buffalo General Hospital since 1936 had a malignant neoplasm. Among 218 tumors that were first recognized in women over fifty years of age, 131, or 60 per cent, were malignant.

Follow-up studies indicate that an over-all cure rate would be of no prognostic value as far as an individual type of ovarian malignancy is concerned.

Primary carcinomas of the ovary comprise the largest group and are highly malignant. Of 89 women

with primary carcinoma of the ovary operated upon, only 6, or 6.7 per cent, lived more than five years. Among the patients known to be dead, 69 per cent died within less than a year from the date diagnosis was first established. Among the few known to have survived more than five years, 70 per cent died as a result of a recurrence.

The ovary is pecularily susceptible to metastatic involvement. Primary ovarian malignancies readily and early shed implanting cells from their surfaces on to adjacent peritoneum, while secondary carcinomas of the ovary do not display this tendency. In 10 cases of secondary ovarian malignancy observed the patients died within a few months after the ovarian growth was removed. In half the cases the ovary did not appear enlarged. The primary tumor most frequently noted by Karsh was carcinoma of the breast; gastric carcinoma was second. Carcinoma of the cervix was a frequent source by direct extension.

Of the rare types of malignancies, sarcomas are the most frequent. Four were observed during a fifteen year period. All occurred in girls twenty years of age or younger and all proved rapidly malignant.

Only 1 of 170 dermoids removed was found to be malignant. The malignant character of embryonic teratomas is usually unquestioned. None of the adult type of teratomas followed have exhibited malignant tendencies.

Granulosa-cell tumors were observed in 14 cases (1.2 per cent) of 1,112 cases of ovarian neoplasms. A long-time follow-up is required before the malignant potentiality of granulosa-cell tumors can be evaluated. Recurrence of supposedly benign granulosa-cell tumors has been found fifteen, sixteen and nineteen years after oophorectomy.

Dockerty and McCarthy noted no evidence of malignancy among 10 Brenner tumors observed at the Mayo Clinic. Five cases from the authors experience indicate a benign course.

Many of the cases of hysgerminomas occur in girls and young women. One of the serious considerations in this particular tumor is the possibility of future child-bearing. It remains questionable whether extensive surgery and post-operative irradiation add to the prognosis and comfort of the patient. Some have advocated prophylactic removal of normal ovaries; however, if we consider the patient at the age of forty-five years no more than 3 per 1,000 will develop ovarian malignancy even if they live another forty years.

For ovarian tumors in general the effectiveness of roentgen therapy is not impressive when an appreciable series of irradiated cases is compared with an equal number in which roentgen therapy was not used. However, the effect of irradiation is unpredictable and a therapeutic trial is probably always indicated. It is generally agreed that irradiation may reduce the bulk of an apparently inoperable tumor to a degree making operative removal possible and more effective. Roentgen therapy may slow the formation of ascitic fluid. Surgical removal of the omentum is often helpful in reducing the bulk of the abdominal mass.

A suggested plan of treatment by Parks is to do an initial laparotomy to establish the diagnosis, followed by a full course of intensive irradiation and then surgical removal of the tumor. The possibility of improving results by more radical surgery seems unlikely since almost 50 per cent have carcinomatosis when first operated upon.

The authors include several statistical tables.—*I. Earl Holmes, M.D.*

RADIOISOTOPES

Pinson, Ernest A. Water exchanges and barriers as studied by the use of hydrogen isotopes. *Physiol. Rev.*, April, 1952, *32*, 123–134.

This is an excellent critical review by an author who has made significant contributions to the field under discussion.

The properties of deuterium and tritium and methods of assay are described, together with a discussion of the reliability of results using as a biological tracer an isotpoe which has a mass 100 per cent and 200 per cent greater than the "natural" isotope protium. The dangers involved in using tritium are taken into consideration, particularly with respect to exchange of water through the skin where it would appear that between the exterior and the extravascular fluid beneath the skin there is a barrier through which water appears to pass in the vapor state; and subjacent to this, there is a second barrier through which water appears to pass in the liquid state and where the rate of exchange is altered by varying skin temperature.

The author points out that one should take into consideration the deuterium or tritium exchange with exchangeable hydrogen atoms in carbohydrate and protein which are calculated to be equivalent to between 1 and 2 per cent of body weight as water. The rapidity with which HDO and HTO come into equilibrium with body H_2O is indicated by several examples, including a half-time of 1.5 minutes for HDO in cisternal cerebrospinal fluid in man.

It is also pointed out that fluids lost from the body contain the same hydrogen isotopic ratio as the blood at the time of such loss, that there is nearly 100 per cent exchange of water in the lungs between body fluids and inspired air, that a linear relationship with time represents the amount of water transferred to the blood from the gastrointestinal tract, and that every minute a greater volume of water passes into and out of the blood than is maintained normally in the total blood volume. It is emphasized that the isotopes of hydrogen permit one to differentiate between net water transfer and water exchange.—*Rodney H. Voss, M.D., Ph.D.*

Oeser, H., and Billion, H. Funktionelle Strahlendiagnostik durch etikettierte Röntgenkontrastmittel. (Functional roentgenologic diagnosis by means of labelled roentgen contrast media.) *Fortschr. a. d. Geb. d. Röntgenstrahlen ver. m. Röntgenpraxis*, April, 1952, *76*, 431–442.

Preliminary studies of the physiology of the liver, gallbladder, and kidneys by means of biliselectan and uroselectan labelled with I^{131} are reported.

After oral or intravenous administration of biliselectan, the following observations were made: (1) urine volume at certain intervals; (2) radioactivity of each urinary specimen; (3) the fraction of the original dose excreted in each specimen, determined by the number of counts per minute divided by the "standard," which was 6,250 counts per minute; (4) total gram per cent excretion; (5) radioactivity over the gallbladder area; (6) degree of roentgenographic visualization of the gallbladder (good, fair, poor, doubtful, or negative). From these data, curves of the concentration of the contrast medium in the urine, excretion in the urine, and urine volumes were plotted and compared with previously established normal curves. Significant alterations without differential diagnostic features were found in cases with diseases of the liver. Detailed results are the subject of a forthcoming paper.

Similar studies with uroselectan were made. By first inserting ureteral catheters, it was possible to study each kidney separately.

The dose of radioactive iodine generally employed in these tests was 100 μc. but 50 μc. may be adequate.—*Joseph Zausner, M.D.*

Julliard, J. and Maupin, B., Loverdo, A., Bernard, Jean, Colvez, P., and Lecomte, M., with the collaboration of Dugas, J., Ardry, R., Hénaff, Perrot, F., Robert, M.-P., and Theilleux, R. Premiers essais de transfusion à l'homme de leucocytes et de plaquettes marqués au radio-phosphore. (First attempts in man of transfusion of leukocytes and platelets labelled with radiophosphorus.) *Presse méd.*, April 9, 1952, *60*, 518–520.

It is known that transfusion of leukocytes leads to only slight, temporary and inconstant increase of the circulating white cell elements of the blood. In animals as well as in human beings hardly one-tenth of the injected leukocytes is utilized, the beneficial effect lasting for a period of about fifteen to thirty minutes. The fate of the bulk of the leukocytes is unknown.

To study this problem the authors performed transfusions of leukocytes and platelets labelled with P^{32} in animals and in 2 patients, one afflicted with chronic lymphatic leukemia and the other with chronic myelogenous leukemia. In this article they pay particular attention to the technique of labelling with P^{32} in vitro, the preparation of the leukocytes and platelets for transfusion, the methods of determining the distribution of the P^{32} labelled elements in the various organs and the results obtained. Short résumés of the two case reports are also given.

The following conclusions are reached:

(1) These preliminary experiments seem to confirm the rapid disappearance of the transfused leukocytes from the circulating blood in man. During the first few hours after injection the radiophosphorus disappears considerably faster when tagged to the leukocytes than when injected in the form of inorganic solution.

(2) A similar behavior is observed in the case of the transfused blood platelets.

(3) Parallel animal experiments show that the leukocytes are arrested predominantly by the lungs, whereas the favorite organ for capture of the platelets is the spleen. Both cell elements are also captured in considerable amounts by the liver.

The radioactivity of the kidneys is low but remarkably constant whether the P^{32} is injected as inorganic solution or as tagged to the leukocytes or platelets.

(4) The observations made are important since they prove that radioactive elements can be successfully used for study not only of the fate of the transfused leukocytes and blood platelets but also of the means by which their capture may eventually be retarded.—*T. Leucutia, M.D.*

Prentice, T. C., Berlin, N. I., and Lawrence, J. H. Effect of therapy on blood volume, blood pressure, and spleen size in polycythemia vera. *A.M.A. Arch. Int. Med.*, April, 1952, *89*, 584–590.

The authors present 20 patients with proved polycythemia vera in whom they have made a total of 44 extensive follow-up studies at intervals averaging 4.6 months. Treatment for the majority of patients consisted of P^{32}, but some were concomitantly treated with phlebotomy and/or Y^{90}. Blood volume changes during therapy were studied by means of P^{32}-labelled red blood cells. The authors generally found blood volume to decrease during adequate therapy. This decrease in blood volume occurred in about an equal number of instances either as the result of (1) a decrease in total red cell volume and a fall in plasma volume, or (2) a fall in total red cell volume and a relatively smaller rise in plasma volume. The factors controlling the type of pattern are unknown and the type of response was not constant even in individual patients. The average change in blood volume was 13 cc. per kg. of body weight.

This study revealed that no clear-cut or constant

relationship could be established between blood pressure and blood volume. In general, spleen size decreased during therapy, but the spleen size could not be adequately correlated with blood volume.

The authors also found that red blood cell counts and hematocrit readings were, in the majority of instances, paralleling changes in total red cell volume, but these determinations were not sufficiently accurate for judging changes in blood volume. A more satisfactory means for evaluating the response to polycythemia therapy is serial determination of the blood volume and total red cell volume.—*John P. Storaasli, M.D.*

Becker, J., and Scheer, K. E. Strahlentherapeutische Anwendung von radioaktivem Kobalt in Form von Perlen. (Radiation therapeutic use of radioactive cobalt in the form of beads.) *Strahlentherapie*, 1952, *86*, 540–547.

Cobalt can be worked like iron. It is strongly magnetic and will corrode. The authors made cobalt beads, 4, 6, and 7 mm. in diameter with a strength of 2.5, 5 and 7 millicuries. The hole through the beads was 1 mm. in diameter for the 4 mm. beads and 1.5 mm. for the others. The beads were electroplated with gold, both to protect them from corrosion and to filter out beta radiation. After using these beads in lieu of radium for ten months, they have found no disadvantages and list the following advantages: no gaseous decay products are formed and thus no air-tight container is necessary; this means of application is physically flexible; the price is relatively low, and the half-life is long, of the magnitude of 5.3 years.

Cobalt beads have been found particularly adaptable to the treatment of carcinoma of the uterine corpus, of the esophagus, of the urinary bladder, and of the paranasal antra. The beads are strung on a nylon thread and can then be introduced into any cavity, natural or operative, through a small orifice and can be withdrawn even more easily. Isodose curves about a cavity packed with the beads show a desirable and even distribution of radiation intensity. Surface applicators have also been made by imbedding the beads in a plastic plaque.

To apply the beads definitively to *one* wall of a cavity, for example to a localized and flat carcinoma of the urinary bladder, a strong magnetic force has been applied to the body in the proper direction.—*Henry G. Moehring, M.D.*

Johns, H. E. Physical characteristics of the radiation in cobalt^{60} beam therapy. *J. Canad. A. Radiologists*, March, 1952, *3*, 2–6.

In August, 1951, a 1,100 curies Co^{60} beam therapy unit, designed by the author, was installed at the University Hospital in Saskatoon. The radioactive cobalt was obtained from the Canadian atomic pile at Chalk River.

In the present article, the author describes briefly the construction of the unit and gives pertinent data on measurements necessary for clinical therapy by including schematic drawings, graphs and isodose distribution curves.

The cobalt source is 1 inch in diameter and $\frac{1}{2}$ inch thick, consisting of 25 individual discs, each 1 inch in diameter and 0.5 mm. thick. The reason for the necessity of very thin discs is discussed; it has to do with the manner of radioactivation in the atomic pile. This source, which was loaded at Chalk River in a stainless steel cup, is placed by a very careful maneuver in a steel-encased, lead-filled cylinder with rounded ends, 20 inches in diameter and 22 inches high, the finished assembly constituting the treatment head. The cobalt is thereby surrounded by 10 inches of lead in all directions except along the axis of the cylinder where it is shielded by 7 inches of heavy metal. The treatment head, which weighs about 1 ton, is supported from an overhead carriage and is made quite flexible by a counterbalanced motor and gear chain system. The unit may be turned on and off by a small two-phase motor connected to a wheel. Interlocks, placed on the doors of the treatment room, return the cobalt immediately to the off position when these doors are opened.

The design of suitable cones encountered some difficulty in view of the fact that lead walls of 8 cm. thickness are required. The author now has 20 different sized fields available and no cone attachment weighs more than 15 lb.

The treatment room has concrete walls 12 inches thick. All movements of the treatment head are controlled by relays from a panel outside the room. The observation window is filled with eight 1 inch layers of plate glass. The overhead support of the treatment head provides ample space for the positioning of the patient for treatment. In the floor of the room is mounted a steel table 8 feet in diameter flush with the floor for rotation therapy.

The author states that the radiation is below tolerance level at all points outside the room when the unit is turned on and that the dose rate 1 foot from the head is less than 5 mr per hour when the unit is turned off.

The physical measurements included determination of the spectral distribution of the gamma radiation emitted by the cobalt source and its comparison with the spectral distribution of the radiation produced by 2 to 3 mev. (peak) roentgen therapy apparatus; determination of the percentage depth dose for square and rectangular fields at 80 cm. source-to-skin distance; and the plotting of isodose distribution curves.

The conclusion is reached that the Co^{60} unit yields depth doses comparable to those obtained from a 3 mev. roentgen apparatus. The present unit has an output of 33 r per minute at 80 cm. It is flexible,

simple to operate and requires practically no service. Its only disadvantage is the necessity of periodical replacement of the source.—*T. Leucutia, M.D.*

Watson, T. A. The clinical possibilities of the cobalt^{60} beam unit. *J. Canad. A. Radiologists*, March, 1952, *3*, 7–10.

The author enumerates the following advantages of Co^{60} beam therapy over supervoltage roentgen therapy: (1) the initial cost is very much less; (2) the unkeep is low; (3) the unit is more compact and maneuverable; (4) the output is constant, being subject to exponential decay (1.1 per cent per month); (5) the beam is much more homogeneous and no filtration is necessary; and (6) a higher depth dose is obtained (which is comparable to that of 3 mev. roentgen therapy). Its disadvantages are: (1) that the cobalt, with a half-life of 5.3 years, will probably have to be replaced in about 3 years and (2) than the focal spot of 2.5 cm. in diameter produces a marked penumbra effect at the edge of the field, which means that, for example, to reduce this penumbra to 6 mm. at 80 cm. source-to-skin distance, the last lead diaphragm must be placed 15 cm. from the end of the cone.

The method has been used on patients at Saskatoon only since November, 1951. It is presumed that it will prove useful in deep-seated malignant neoplasms in which small or medium size fields are required for crossfiring. Among these are included cancers of the larynx, pharynx, esophagus, and possibly lung, parametrial involvement in cancer of the cervix, and postoperative irradiation of the axilla and supraclavicular region in cancer of the breast. Rotation therapy of both the horizontal and vertical type is also contemplated and, for this reason, a section of the floor, 8 feet in diameter, was provided with a rotating mechanism.

The author uses open-end cones rather than adjustable diaphragms since such cones permit compression. A compression rod, back pointer, and pin and arc can all be fitted to a single fixture on the master cone. The treatment head is positioned by 3 pairs of push-buttons in a single small box which is held in one hand; one pair of buttons for up and down movement, one for back and forth and one for rotation. The treatment couch has a mechanically operated movable top and can be pumped up or down.

The article is illustrated with photographs and diagrams showing the "compression rod," the "back pointer" and the "pin and arc" in use, and a model set up for horizontal rotational therapy with the patient lying supine on the treatment couch placed on the rotating platform.—*T. Leucutia, M.D.*

Dixon, W. R., Garrett, C., and Morrison, A. Room protection measurements for cobalt^{60} teletherapy units. *J. Canad. A. Radiologists*, March, 1952, *3*, 11–15; also *Nucleonics*, March, 1952, *10*, 42–45.

The authors deal in extenso with the problems of room protection when using Co^{60} beam units for treatment. These problems include protection against the direct beam and protection against scattered radiation.

The following aspects are presented: (1) for the specification of the protection against the direct beam: (a) influence of the gamma-ray intensity, (b) the maximum beam size at the wall or floor in question, and (c) the attenuation of the radiation in the protective material (concrete and lead); and (2) for the specification of the protection against scattered radiation: (a) intensity distribution of the gamma radiation scattered from an elliptic masonite phantom, (b) intensity distribution of the gamma radiation scattered from a concrete wall 8 inches thick, and (c) the absorption of the scattered radiation by the protective material (concrete and lead) for various angles of scatter. For a Co^{60} source the energy of the scattered radiation is in the range of 200 to 1,200 kv., depending on the angle of scatter.

Graphs are given expressing the absorption in concrete and lead of the direct beam of Co^{60} gamma rays and of the scattered gamma radiation for various angles of scattering as produced by an elliptic masonite phantom and an 8 inch concrete wall normal to the beam. Finally, an example is cited illustrating how, with the aid of these graphs, one may calculate the thicknesses of the various walls of the treatment room (front wall, side walls, back wall, floor and ceiling) for adequate protection of the personnel working in the area of a given Co^{60} teletherapy unit.—*T. Leucutia, M.D.*

Smith, Ivan H. Cobalt^{60} beam therapy; some influences and advantages. *J. Canad. A. Radiologists*, March, 1952, *3*, 16–19.

A 1,300 curie Co^{60} beam therapy unit went into clinical operation in London, Ontario, on October 27, 1951. Up to the publication of this article, 51 patients have been treated.

The author lists his initial impressions as follows: (1) Co^{60} teletherapy will not replace conventional methods of irradiation; (2) it will expand the effectiveness of irradiation; (3) it requires a radiation physicist; (4) it places added emphasis on centralization of radiation therapy; (5) it will place us closer to "state medicine;" (6) it, or its equivalent, will be a "must" for any department handling 500 new therapy cases per year; and (7) it enables utilization of rotation therapy to the fullest advantage.

He uses 3 representative cases to illustrate the fact that the dose distributions when crossfiring with the same numer or portals is more efficient in Co^{60} beam therapy than in the conventional 250 kv. roentgen therapy. These are: a case of recurrent angioendothelioma of the right posterior nasal cavity, a case of extensive inoperable carcinoma of the rectum and a case of early but technically inoperable bronchogenic carcinoma of the carina. The physical

factors of the Co^{60} beam therapy are: a half-value layer of 14.9 mm. Cu, a depth dose (at 10 cm.) of 56 per cent using 6 by 8 cm. fields and an output of 20 r per minute at 100 cm. distance.

Graphic representations of the comparative dosage distributions in the 3 cases are given.—*T. Leucutia, M.D.*

Green, D. T., and Errington, R. F. Considerations in the design of a cobalt^{60} beam therapy equipment. *J. Canad. A. Radiologists*, March, 1952, *3*, 20–24.

The authors, who are members of the staff of the Commercial Products Division of the Eldorado Mining and Refining (1944) Ltd., present a detailed description of the equipment which they have designed for the use of pile-produced Co^{60} sources of high output, small physical dimensions and high energy for clinical therapy.

The items considered include source handling and loading, treatment head, beam definition and positioning.

In its present form the unit is designed for sources with a maximum diameter of 3.3 cm. and a maximum output of 60 roentgens per minute at 1 meter distance. A method has been provided for loading sources into the treatment head after the unit is installed in a hospital, and for replacing the decayed sources with new full strength sources. Lead totally encased in steel is used for protection, and measurements show that the dose is well below 6.25 mr per hour over the greater part of the shield surface. The shutter mechanism for turning the beam "on" and "off" closes by gravity with the aid of mercury moved by compressed air, involves no movement of the source and incorporates many safety provisions. The size of the beam is regulated by a single-plane defining system which consists of a combination of a steel channel and lead blocks allowing instant adjustment to infinite variety of square and rectangular apertures. To assist in the orientation of the field on the patient, a light beam is arranged to approximately duplicate the radiation beam through the aperture. The treatment head is supported by a "gallows" type mount, the horizontal arm of which is 42 inches long, corresponding to more than half of the length of a treatment table, while the vertical pedestal is only 19 inches wide so as to allow good maneuverability of the treatment table. The positioning of the treatment head is controlled by a small portable push-button station which is connected by a flexible cable to the vertical pedestal of the unit. The room housing the unit must have a floor space of 12 by 16 feet and a ceiling height of 9 feet.

The finished commercial unit is illustrated by a photograph and parts of it are presented diagramatically.—*T. Leucutia, M.D.*

Ter-Pogossian, Michel, and Sherman, Alfred I. Handling of radioactive gold for therapeutic purposes. *Nucleonics*, March, 1952, *10*, 23–27.

This excellent article deals with the necessary instrumentation and techniques used for the therapeutic handling of Au^{198} based on the experience gained at the Washington University School of Medicine, St. Louis, Missouri, over a period of three years.

The problem is greatly facilitated by the fact that radioactive gold can now be obtained commercially in a sterilized colloidal suspension (Abbott Laboratories, North Chicago, Ill.). After purchasing the suspension ready for injection, the handling in the hospital laboratory consists of (1) dilution of the colloidal suspension with a given solution to the desired specific activity, (2) transportation of the material to the operating room and (3) injection of the prepared radioactive gold suspension.

If an isotope laboratory is already available, the handling of the Au^{198} is, of course, entrusted to that laboratory. Otherwise a small laboratory must be provided for storage of the radioactive gold, for its required dilution and for the storage and decontamination of the instruments used. The plan of such a small laboratory is presented in detail. It is emphasized that remote-control devices must be used to handle the radioactive material. Long-handled tongs, remote-controlled pipetting, shielded containers and shielded syringes all aid in keeping radiation exposure to the minimum. They are described at length and illustrated. The monitoring instruments must be of two types: (a) a portable dose meter, sensitive to beta rays emitted by Au^{198} and gamma rays, with several scales covering a sensitivity range between 0.2 and 2.0 mr per hour; and (b) several small pencil-type ionization chambers with a range of 200 mr. The former is used to check the adequacy of the protection during the handling of the radioactive gold, whereas, the latter are worn (attached to the sleeve) by the persons working with the substance.

The commercial radioactive colloidal gold is supplied in bacterin vials of 5, 10, 20 and 30 cc., which are shipped in a lead container. Upon receipt, the bacterin vial or vials are quickly transferred to lead beakers and stored in the laboratory for the necessary use. The system employed to withdraw a given amount of the material from a bacterin vial is described and illustrated diagrammatically. Saline or pectin solution is added to bring the specific activity of the suspension to the desired value. The authors state that measurements showed that a right-handed operator withdrawing 100 mc. of the radioactive gold from a 30 cc. bacterin vial that contained half of a 1,070 mc. shipment received 20 mr on the right wrist, 5 mr on the left wrist and no exposure on the chest while performing this operation.

The diluted radioactive gold suspension is transported to the operating room in a specially con-

structed shielded container. A plastic tube with a weighted end is lowered into the colloidal suspension through a hole provided in the top of the container. This tube leads to a three-way value that connects it to the shielded syringe.

Clinically, injection of colloidal Au^{198} has been used (a) intraparametrially, for example, in carcinoma of the cervix; (b) intracavitarily, as a rule in pleural effusions and ascites, following preliminary removal of the fluid; and (c) directly into tumor masses such as viginal metastases and malignant neoplasms of the breast. The local topographic situation usually dictates the type of needle necessary to which then the shielded syringe is attached. Great care must be exerted to avoid spillage or contamination of any sort during the injection. The used surgical instruments must be carefully washed by a competent nurse. The contaminated gloves, towels, sheets and sponges must be stored in a remote cabinet (for 6 weeks or longer) until the radioactivity has decayed to less than 0.1 mr per hour. After that the sponges can be discarded, the other items can be washed and re-used. Certain precautions should be observed during the period of hospitalization also around the patient's bed, although separation in a private room is not necessary. For the protection of the nursing staff the authors strongly recommend that (a) no nurse should be allowed to be closer than 1 meter to a radioactive patient more than once a week, otherwise rotation should be used; (b) all nursing care of a radioactive patient should be reduced to the absolute minimum; (c) all nurses attending radioactive patients should wear a pocket dosimeter or a film badge; and (d) that these rules should be enforced for a period of at least ten days following the injection of the radioactive material.—*T. Leucutia, M.D.*

Morrison, A., Dixon, W. R., Garrett, C., Johns, H. E., Bates, L. M., Epp, E. R., Cormack, D. V., and Fedoruk, S. O. Multicurie cobalt 60 units for radiation therapy. *Science*, March 21, 1952, *115*, 310–312.

A constant aim in cancer therapy is to increase percentage depth dose. Two (of several) contributing factors are discussed: (1) the source-skin distance (SSD) is important because of the inverse square law relationship, and (2) the energy of the radiation is a consideration as with increasing energy, penetration, and therefore the dose at depth, is increased. For Co^{60} practically monoenergetic gamma radiation (1.17 mev. and 1.33 mev.) is emitted as it decays (half-life 5.3 y) to Ni^{60}. With this radiation the maximum dose is delivered 5–6 mm. below the surface.

It is possible to produce Co^{60} with specific activities of 20 or more curies/gm. One gram of Co^{60} with an activity of 20 curies will have an output equivalent to 32 gm. of radium.

The problems involved and the eventual design of two teletherapy units (Co^{60} of 1,000 curies each—about 20 curies/gm. specific activity) are clearly described. The output from each unit is 33 r/min. at 80 cm. SSD. This compares favorably with large sources of radium (5–10 gm). where the output is of the order of 10 r/min. at 10 cm. from the source. Radium sources larger than 10 gm. lose appreciable amounts of radiation due to self absorption.

A table compares the depth dose of Co^{60} with published information on a 2.0 mev. Van de Graaff roentgen-ray generator. At 100 cm. SSD the percentage depth dose is significantly greater for the Co^{60} source; in fact, the authors believe it is more nearly comparable with 3 mev. roentgen rays. —*Zygmunt S. Gierlach, M.D.*

Reid, Allen F., and Sorenson, Jeanette A. Effective thyroid depth and compensating measurements for iodine uptake determination. *Radiology*, March, 1952, *58*, 390–392.

A method for calculating I^{131} uptake by the thyroid gland using skin-Geiger tube distances of 2 and 13.3 cm. is presented. By placing a phantom containing I^{131} at various distances between 1.5 and 8.0 cm. from the 2 cm. point, a "normalizing factor" curve is plotted against the ratios of the counts observed at the 13.3 and 2 cm. distances. This normalizing factor is used to correct for the effective center of depth of the thyroid gland. A method for determination of non-thyroid tissue background adaptable to the above method is also presented.—*Martin B. Goodwin, M.D.*

Foote, J. B., Mackenzie, D. H., and Maclagan, N. F. A comparison of radioactive and metabolic methods of investigating thyroid function. *Lancet*, March 8, 1952, *1*, 486–488.

The authors compare their radioiodine thigh-neck clearance method with the basal metabolic rate. Plotting data from the above two tests in 140 untreated patients (52 thyrotoxicosis, 67 euthyroid or doubtful, 9 normal persons, 8 hypothyroids, and 4 Simmonds's disease) gave a correlation coefficient of $+0.76 \pm 0.035$. In general the two tests are corroborative, but overlap does exist. None of the 52 thyrotoxicosis patients gave a normal thigh-neck clearance value, while 12 of them had normal range (80–120 per cent) basal metabolic rates. Of 12 hypothyroids, 5 gave normal basal metabolic rates while only 1 (Simmonds's disease) had a normal clearance. Fifty-six normal clearances and 53 normal basal metabolic rates were present in the 67 euthyroid group. From the above, an advantage can be claimed for the thigh-neck clearance over the basal metabolic rate. The clearance/B.M.R. ratio had no significant relation to age, sex, length of history, size of goiter, or degree of exophathalmos.

In treated patients correlation does not exist; with

goitrogens the B.M.R. is normal or low, and clearance is high; with thyroid therapy the B.M.R. is normal or high, and clearance is low; with iodine the B.M.R. is high or normal, while clearance is normal or low.

The thigh-neck clearance is of diagnostic usefulness in untreated patients. Factors involved in lack of correlation in treated patients are discussed.—*Zygmunt S. Gierlach, M.D.*

KASS, IRVING. Studies on the in vitro effects of radioactive I^{131} labeled 3,5 diiodo PAS on the tubercle bacillus. *Am. Rev. Tuberc.*, March, 1952, *65*, 316–324.

Using I^{131} and I^{131} labeled 3, 5 diiodo PAS (para-amino-salicylic acid) tuberculostatic activity and uptake studies were performed in vitro. Tubercle bacilli of a stock culture strain H 37 Sv of constant virulence were suspended in 5 cc. of Difco (I^{54720}) broth.

Radioactive iodine of specific activity 5.45×10^{-1} mc. did not influence growth, and iodine in concentration greater than 500 micrograms (cc.) was required for inhibition of bacilli growth.

The activity of I^{131} labeled 3, 5 diiodo PAS was the same as unlabeled diiodo PAS. In each case more than 2.5 micrograms (cc.) was required for inhibition of growth. The radioactive compound had a specific activity of 2.5×10^{-5} mc. (cc.).

I^{131} labeled 3, 5 diiodo PAS and I^{131} each with specific activity of 0.1 millicurie were added to separate tubes of bacteria. After five days of incubation the bacteria were washed and the radioactivity determined. I^{131} gave no more disintegrations per second than background. The I^{131} labeled diiodo PAS averaged 3.4 disintegrations per second, or 1.5 distintegrations per second over background. This represented a positive uptake of the compound by the bacilli.

Reasons for the failure of increased inhibition of growth of I^{131} labeled diiodo PAS can only be postulated: I^{131} emits gamma and beta rays. The absence of alpha particles may be a factor. The failure of the gamma and beta rays to produce longer wavelengths within the bacteria may be another factor.—*Edward Julien, M.D.*

SWEET, WILLIAM H., and JAVID, MANUCHER. The possible use of neutron-capturing isotopes such as boron^{10} in the treatment of neoplasms. I. Intracranial tumors. *J. Neurosurg.*, March, 1952, *9*, 200–209.

Preliminary work on the potential application of slow neutrons in man for the treatment of intracranial lesions is presented. A problem of supreme importance is to increase isotope concentration in neoplastic cells to a significantly higher degree then in normal cells. From the literature it is known that radioisotopes or radiocompounds may reach, at certain times, levels 30 to 100 times the concentration in normal white matter. A stable atom with a significant concentration difference between normal and tumorous tissue, which would give off radiation following directed neutron bombardment, could yield large amounts of lethal energy in the specified volume.

A basic review of the pertinent underlying physical factors is given. Of the atoms having a high slow neutron capture cross section, the lighter isotope of boron (B^{10}) was selected; toxicity of boron has been worked out; and it was found that large intravenous doses can be tolerated by man. The reaction is:

$$B^{10}+n\rightarrow(B^{11})\rightarrow Li^{7}+\alpha^{++}(2.4\text{ mev.})$$

The alpha particle is the immediate capture radiation, and travels only about 14 μ in tissue.

Borax (5 g.) was given intravenously to 23 patients, and borax plus glycerol (to possibly decrease normal brain content) to 35 other patients. Time intervals under thirty minutes gave most favorable ratios. Of 16 cases of glioblastoma multiforme, 7 had a significant tumor : brain differential (more than 3:1) the maximum in one case being 48:1 at ten minutes. It was not blood content but the tumor itself that was taking up boron.

A discussion of the amount of boron necessary to produce the required ionizing effect from slow neutron capture follows. With B^{10} concentration of 50 μg./gm. in tumor and 15 μg./gm. in normal brain, the evolved energy in the tumor will be three times the normal ionizing effect.

Techniques for attaining maximum effect from the thermal neutrons, a beam of which is rapidly reduced in intensity in traversing tissue, are considered.—*Zygmunt S. Gierlach, M.D.*

CHEMOTHERAPY

BERSON, SOLOMON A., and YALOW, ROSALYN S. The effect of cortisone on the iodine accumulating function of the thyroid gland in euthyroid subjects. *J. Clin. Endocrinol. & Metabol.*, April, 1952, *12*, 407–422.

The effect of cortisone on thyroid function was evaluated by studying the thyroid and renal plasma I^{131} clearance rates and/or the twenty-four hour uptake in 24 euthyroid patients. In 17 of 18 patients who received cortisone in daily doses of 100 milligrams or more, a marked depression of thyroid accumulation rate of I^{131} as well as the thyroid I^{131} clearance rate was found. A return to normal pretreatment levels occurred after cortisone therapy was stopped. When the daily dose of cortisone was less than 100 mg., very little effect on thyroid function was observed. The authors found no correlation between thyroid accumulation of I^{131} and the basal metabolic rate or serum cholesterol during cortisone therapy.

The renal plasma I^{131} clearance rate was found to

be elevated in those patients whose thyroid function was depressed by cortisone. Because of this, the twenty-four hour thyroid uptake of I^{131} which is dependent upon the clearance rate is not a reliable index of thyroid function. On the other hand, the thyroid plasma I^{131} clearance rate which is not influenced by renal excretion is an absolute measure of thyroid function.

The authors feel that the thyroid inhibition is due to a direct effect of the cortisone on the pituitary gland.—*John P. Storaasli, M.D.*

Kasdon, S. C., Fishman, W. H., Dart, R. M., Bonner, C. D., and Homburger, F. Methylandrostenediol in palliative treatment of breast cancer. *J.A.M.A.*, April 5, 1952, *148*, 1212–1216.

The authors give a critical evaluation of the usefulness of methylandrostenediol (stenediol and methostan, Organon Co., Orange, N. J. and Schering Co., Bloomfield, N. J.) as a palliative agent in recurrent or inoperable carcinoma of the breast. The results in 44 cases are described, 7 having been previously reported. Of the 44 patients, 30 showed improvement and 14 showed no change in the progressive course of the disease while receiving methyl androstenediol.

Dosages used were 25 mg. six times a week in oil suspensions, or 100 mg. three times a week in aqueous suspensions for ambulatory patients or 100 mg. seven times a week for hospitalized patients.

The undesirable effects observed are: (1) hypercalcemia, (2) hirsutism, (3) increased libido, (4) acne. Except for hypercalcemia, the side-effects are less pronounced than with testosterone, while the favorable effects are as good as with testosterone. It is considered that the beneficial action is brought about through anabolic properties and not through a carcinolytic or carcinostatic effect.

Four illustrative case reports with reproductions of microphotographs and roentgenograms are presented in the article.—*William H. Shehadi, M.D.*

Schmitz, Herbert E., and Smith, Charles J. Primary treatment of cervical carcinoma with "krebiozen." *J.A.M.A.*, March 8, 1952, *148*, 843–844.

This is a case report of a woman, aged fifty-six, with a primary transitional cell carcinoma of the cervix, selected among a group because it was felt that an untreated, relatively early cervical malignant growth would offer an opportunity to evalute the effect of the drug "krebiozen."

Treatment consisting of administration of 1 cc. of "krebiozen" was begun on June 12, 1951, and repeated June 15. An examination on July 9 revealed no change in the appearance of the lesion. On July 10, 13, the third and fourth doses of "krebiozen" were given and examinations up to September 15, 1951, showed no regression of the growth and a photomicrograph showed no intrinsic cellular change.

On September 24, a total abdominal hysterectomy, bilateral salpingo-oophorectomy and pelvic lymphadenectomy were done, and a pathological study of the tissues removed revealed no evidence of tumor cells except at the primary site, where the growth involved both cervical lips and a large portion of the cervical canal.

The authers concluded that there was no evidence that "krebiozen" had any curative or destructive effect on the lesion.—*William W. Maver, M.D.*

Winkelmann, Horst. Über die chemotherapeutische Kavernentamponade nach Maurer. (On the chemotherapeutic tamponade of cavities according to Maurer.) *Tuberkulosearzt*, March, 1952, *6*, 153-161.

The author treated by this method 35 cases of unilateral and 2 cases of bilateral tuberculous cavities indicating very poor prognosis, as well as 1 case of lung abscess and 2 cases which later turned out to be cavitating carcinomas.

The technique is not described but reference is made to Maurer's original paper. It is a relatively simple procedure in which a cavernostomy is made and a tampon saturated with chemotherapeutic agents is inserted. Tuberculous patients too toxic for major operative intervention (such as thoracoplasty) can be improved so remarkably that subsequent surgery can be carried out without serious complications. Surgery must follow early, however, before epithelization of the cavity and the stoma takes place and introduces the possibility of bronchial fistula.

The cases are divided into 6 groups based on roentgenologic findings. Indications and prognosis are discussed and results given in tables.

The closure of the bronchus draining the cavity is not absolutely necessary for its healing but contributes to it as well as to secondary thickening of the pleura in the vicinity of the cavernostomy.

An absolute indication for tamponade is unrelenting hemorrhage into a cavity.

The conclusion is reached that the procedure is an important addition to the treatment of tuberculosis. —*Frederick M. Reis, M.D.*

Cromer, J. Keith, Bateman, Jeanne C., Berry, G. Neill, Kennelly, John M., Klopp, Calvin T., and Platt, Lois I. Use of intra-arterial nitrogen mustard therapy in the treatment of cervical and vaginal cancer. *Am. J. Obst. & Gynec.*, March, 1952, *63*, 538–548.

The material consists of 16 patients, 14 of whom had epidermoid carcinoma, 1 adenocarcinoma and 1 anaplastic carcinoma; 14 had carcinoma of the

cervix and 2 had carcinoma of the vagina. The method of introducing the HN_2 through a polyethylene tube into the arteries supplying the pelvic organs is described in considerable detail. The patients were made ambulatory the day following surgery, unless they were bed-ridden for other reasons.

In the first few cases, an arbitrary total dose of 40 mg. was used but in subsequent patients therapy was guided by a peripheral blood and bone marrow reaction. The total dose administered ranged from 24 to 82 mg.

Two patients with far advanced disease demonstrated dramatic clinical improvement, although this lasted only a few months. Some degree of pain relief was observed in the majority of the patients treated. Side-effects of the therapy included some nausea in 8 patients though never as severe as that anticpated with intravenous HN_2 therapy.

The authors describe at length the clinical effects on the lesion, the microscopic changes, the cytological and cytochemical alterations, and the hematological reaction to the therapy. A summary of the clinical data regarding each of the 16 cases is included.

Seven patients who presented clearly visible and palpable lesions showed evidence of regressive alteration in the tumor mass during the course of therapy. This consisted of a distinct reduction in the size of the visible portion of the lesion, as well as a reduction of the palpable extent of the tumor mass. Reduction in the size and substance of the cervical lesion was apparent by the fourth day and marked by the eighth day of treatment.

Five patients received cortisone simultaneously with HN_2, 1 prior to and 1 following the course of HN_2. In no instance was there any evidence of enhancement of the local HN_2 effects which could be attributed to the use of the steroid.

Three patients without prior treatment of any form were given a trial on HN_2 before institution of roentgen therapy. Tissue sections were never free of tumor cells at any time during the course of therapy and up to the beginning of roentgen therapy.

Bone marrow depression manifested by a decrease in cellularity and diminution of young forms preceded severe peripheral granulopenia by several days. Where examination of iliac crest marrow was made, an earlier and more lasting depression was noted than that observed on sternal marrow and was attributed to the localized action of HN_2. Adjuvant cortisone therapy appeared to exert a mildly protective effect on bone marrow.

That destructive changes can be produced in pelvic cancer by the use of intra-arterial nitrogen mustard therapy has been amply demonstrated. However, little is gained clinically from the use of the method in the group with advanced local diseases plus distant metastases except for relief of pain and an improvement in the general well-being. Where local effects were demonstrated, distant changes were negligible. Destruction of regional lymph node metastases at the level of therapy, as revealed by autopsy findings in 1 patient in this series, would suggest usefulness of the method in preventing lateral spreads in conjunction with radiation therapy.

The results indicate that the method may be used either alone or in combination with irradiation for palliative treatment of cervical cancer; and possibly as an adjunct to radiation therapy in definitive treatment.—*I. Earl Holmes, M.D.*

Metcalfe, R. H. Secondary carcinoma in bone treated by dienoestrol. *Proc. Roy. Soc. Med.*, Feb., 1952, *45*, 87–88.

A case history of a sixty-five year old female with metastatic carcinoma of the breast in bone treated by dienoestrol is presented.

A right radical mastectomy for carcinoma of the breast was performed in 1944. In 1947 the patient noted a small swelling on the left forehead for which she was not treated. On March 20, 1951, she fell on the stairs and sustained a pathological subtrochanteric fracture of the right femur. Roentgenograms showed the femoral fracture to good advantage as well as the frontal bone involvement. The patient was treated continuously to the present time receiving dienoestrol, 5 mg. t.i.d. By July 31, 1951, the skull tumor was greatly decreased in size, practically invisible to inspection. Roentgenograms made on September 25, 1951, showed disappearance of the metastatic process and the fracture of the femur was united. On November 1, 1951, the patient was out of bed walking slowly with no evidence of neurological disturbance.— *Donald R. Bernhardt, M.D.*

MISCELLANEOUS

Miller, Earl R. A device for immobilizing children during radiographic examinations. *Radiology*, March, 1952, *58*, 421–423.

Ordinarily, infants or small children are held manually by parents or departmental personnel when roentgenograms are to be made. This exposes such persons needlessly to irradiation, and too often the results of examination are unsatisfatory. A device for immobilization of such patients, called the "brattbored" by the author, is simply made of properly cut pieces of 3/8 inch 3-ply plywood. A series of such pieces are shaped roughly like the human body, with the "arms" at various positions in relation to the "trunk." The child is fastened to the proper "board" by two 2 inch elastic bandages, one about the pelvis and legs, and one across the upper chest and about the arms. The "board" is fastened to a heavier plywood "vise" which forms an L-shaped base, allowing exposures to be made reclining, upright, or laterally. The plywood does not appear on the roentgenogram, except as faint lines representing the edges of the "board."—*Lynne Taylor, M.D.*

Bell, A. L. L., and Zwanger, Jerome. A simple accurate plane and incline indicator. *Radiology*, Feb., 1952, *58*, 259–260.

A simple device for indicating the degree of table inclination is described. It consists of a semicircle of glass tubing containing a droplet of mercury, the whole being imbedded in wood or plastic which is graduated at 30 and 90 degrees. The mercury droplet seeks the lowest point in the glass tube as the table angle is changed. The apparatus is fixed to the spot film device so that its image appears on one side of each spot roentgenogram.—*Martin B. Goodwin, M.D.*

Russell, Liane Brauch, and Russell, W. L. Radiation hazards to the embryo and fetus. *Radiology*, March, 1952, *58*, 369–377.

Following total body irradiation (25–300 r) to large groups of pregnant mice at accurately determined stages of gestation spaced at twenty-four hour intervals, the following conclusions are reached.

1. The embryo is directly susceptible to induction of malformations by irradiation. A dose of 25 r at a critical period can produce abnormalities in mice.

2. There are well defined critical periods in the development of most characters; *e.g.*, a particular abnormality may have a high incidence following irradiation during only one stage of development.

3. By using "cross-reference points" in the development of the embryo, the critical period for the majority of the deformities in man would be between the second and sixth weeks of pregnancy.

4. Irradiation occurring later in pregnancy may produce abnormalities not noticeable at birth but which become apparent in infancy and childhood.

5. Doses high enough to produce abnormalities do not necessarily cause prenatal death.

In view of the above, the following recommendations are made:

1. If possible, irradiation of the abdomen in women in menarche should be avoided except at the time of ovulation. Such a procedure is recommended because a diagnosis of pregnancy usually has not been made when the radiation effect is most critical (2 to 6 weeks).

2. Irradiation to the fetus should be avoided during known pregnancy.—*Martin B. Goodwin, M.D.*

Gershon-Cohen, J., Hermel, M. B., and Griffith, J. Q., Jr. Protective effect of small lead shields during repeated whole-body x-ray irradiation of rats. *Radiology*, March, 1952, *58*, 383–389.

White rats, 110 days old, were irradiated with 600 r (half-value layer 1.1 mm. Cu, 50 cm. distance) in 280 seconds. External lead shields approximately covering the tail, head, spine, liver, right lower abdomen, right lung or spleen were applied to comparative groups of 10 rats each, the average area shielded being 15 per cent of the effective body area. There were 4 deaths in the group of 10 rats having no shielding while there were no deaths in any of the shielded groups. A second equal exposure thirty days later resulted in 7 deaths in the 69 rats comprising the shielded groups while there were no further deaths in the control group. The weight and hemoglobin of the individual shielded rats were only slightly modified by the treatment, while the white blood cell count was markedly reduced. In general, the changes were slightly greater following the second period irradiation.

It is suggested that the small shield protects enough erythropoietic tissue to prevent marked changes in the blood elements produced by such tissue.—*Martin B. Goodwin, M.D.*

Azarnoff, Daniel L., and Roofe, Paul G. The effects of total body roentgen irradiation on the endocrine glands and other organs of the rat. *Tr. Kansas Acad. Sc.*, 1952, *55*, 184–195.

Following total body irradiation, animals develop marked anorexia with a decrease in food intake and a loss of weight. Absorption of certain food-stuffs is inhibited. It is difficult to determine which of the effects are due to irradiation and which to inanition.

The authors feel that for long-term experiments the best method of approaching control conditions is by pair-feeding, whereby a group of animals is fed the same amount of food eaten by the irradiated animals.

Using this method, the authors studied the effects of total body irradiation on various organs of the rat, to determine which of the changes occurring in the irradiated animals also occurred in the pair-fed controls.

Adult male rats were used and were divided into three groups: Group I was fed food and water as wanted; Group II was exposed to 412.5 r total body irradiation. This group was also fed as desired. Group III was not irradiated but was pair-fed with Group II.

The gross and microscopic results on various organs of all the animals are given. The most significant changes were observed in the spleen and liver. The spleens of the irradiated group were 40 per cent smaller than those of the normal, whereas those of the pair-fed group were only slightly smaller than normal. The greatest damage was found to be chiefly to the lymphocytes of this organ.

The weight of the liver of pair-fed animals was less than that of the other groups. This was not due to water loss from this organ. The livers of irradiated rats showed a significant decrease in total nitrogen.

The authors conclude with a discussion of the similarity between the changes produced by total body irradiation and those produced by starvation. They feel that injury produced by this irradiation is not completely due to direct damage, but is also

due to changes which are similar to the general adaptation syndrome described by Selye. They believe that the starvation following total body irradiation can produce all the tissue changes they describe with possibly the exception of the effect on the liver and spleen.—*Elizabeth M. Bogardus, M.D.*

Lambou, M. G., Mayne, R. Y., Proctor, B. E., and Goldblith, S. A. Effects of high-voltage cathode-ray irradiation on cottonseed. *Science*, March 7, 1952, *115*, 269–271.

The authors describe the adverse effect of high voltage cathode rays on germination and growth of cottonseed when applied in sufficient strength to destroy associated microorganisms.

High voltage roentgen rays and cathode rays are known to destroy pure cultures of molds and bacteria at minimal doses of 1,000,000 and 1,500,000 roentgen equivalent physical (rep). This knowledge has been used in the sterilizing of ground beef, fish slices and other food with the desired effect, except that at the dosages required for sterilization, enzymes in foods are slightly affected.

In the present investigation, two types of cottonseeds were used and these were irradiated in increments of 500,000 rep up to 3,000,000 rep in group samples and with controls. The effects of ionizing radiations on cottonseed were measured in terms of moisture and free fatty acids, total and internal microbial populations, germinability and growth.

The study showed increasing inhibition of germination and growth of cotton seedlings with increasing dosages of high voltage cathode rays which suggests that one or more enzymes asosciated with germination and growth were inactivated by the rays.—*William W. Maver, M.D.*

Marks, Hirsch. Clinical experience with irradiation through a grid. *Radiology*, March, 1952, *58*, 338–342.

The grid technique of roentgen therapy makes it possible to deliver a much larger tumor dose through the skin. The grid consists of a lead-rubber 8 mm. in thickness with apertures 1.5 cm., 1 cm., and 0.5 cm. square or in diameter uniformly distributed. Empirically, the open sections of the grid have been established at 40 per cent and the covered section at 60 per cent.

By placing the grid openings in the same position at each treatment, the covered untreated skin provides healthy tissue from which healing extends to the areas of radiodermatitis.

The optimum dosage for various malignancies and anatomical locations is discussed.

This method is especially advocated for advanced carcinomas of large volume. The author stresses that the method of application is clinical and cannot be carried out according to prescription. The response of the skin to healing and the regression of the malignancy are dependent upon the clinical condition of the patient.—*Everett E. Seedorf, M.D.*

Harris, William. Recent clinical experience with the grid in the x-ray treatment of advanced cancer; preliminary report. *Radiology*, March, 1952, *58*, 343–350.

The author describes his use of grids for roentgen therapy of advanced cancer. The grid is made of 4 mm. of lead rubber for 200 kv., which allows transmission of 3 per cent of the radiation applied to the surface through the closed areas. The same openings are used throughout the treatment. For a flat surface, openings of 1 cm. in diameter are used and on irregular surfaces, openings of 1.5 cm. in diameter are more satisfactory. The open areas always equal 40 per cent of the total portal area.

Physical measurements indicate that there is an advantage in depth dose with the grid over the conventional open portal method. It is assumed that normal tissue can tolerate larger doses given by this method.

The author concludes that 18,000 r to one portal should not be exceeded and that the dose should be protracted over a period of thirty-five to forty-five days.

The most promising results were obtained in cancer of the lung and urinary bladder.—*Everett E. Seedorf, M.D.*

Loevinger, Robert. Depth dose curves for grids in x-ray therapy. *Radiology*, March, 1952, *58*, 351–360.

Graphs are discussed showing the depth dose, the scattered dose, and the total dose for conventional open field roentgen therapy and for roentgen therapy employing a 40 per cent open and 60 per cent closed grid over the irradiation skin portal.

A method is presented for analyzing therapy depth doses into primary and scattered fraction. The formula makes it possible to compute the maximum and minimum depth doses which will occur with the use of the treatment grid. The ratio of maximum to minimum is large at the surface but drops rapidly at a depth, due to scattered radiation.

By employing a treatment grid it is possible to give about twice as much radiation to the underlying tissues as is possible without the grid.—*Everett E. Seedorf, M.D.*

Garrison, Hugh, Anderson, John, Laughlin, John S., and Harvey, Roger A. Comparison of dose distributions in patients treated with x-ray beams of widely different energies. *Radiology*, March, 1952, *58*, 361–368.

This article gives a comparison of the dosage distribution of roentgen rays from a 400,000 volt

apparatus with that of a 23,000,000 volt betatron. Differences in the absorption of the radiations from these two sources are as follows:

(1) The maximum dose of 400 kv. roentgen rays with a half-value layer of 2.75 mm. Cu is approximately at the surface, while with the betatron it is slightly over 4 cm. below the surface.

(2) The relative dose of 400 kv. roentgen rays is 37 per cent at 10 cm.; with the betatron it is 81 per cent at 10 cm.

(3) Side scatter is considerable with 400 kv. roentgen rays, but with the betatron the scatter is predominantly forward.

(4) The entrance skin dose represents the peak with 400 kv. roentgen rays and is approximately 35 per cent of the peak dose with the betatron. The exit skin dose is usually negligible with 400 kv. roentgen rays, while with the betatron it may be higher than the entrance skin dose.

(5) Relative absorption of the radiations is high in bone and low in fat at lower voltages; it is more nearly equal with the betatron.

The average dose unavoidably delivered to healthy tissues is an important criterion in the evaluation of radiation treatment at any energy level. The lower this dose, the fewer the symptoms of radiation sickness the patient is likely to experience, and the greater the healing of the tumor bed.

The 23 mev betatron yields a more uniform tumor dose in most internal neoplasms, with a lower integral dose per tumor dose and a lower average dose in unavoidably irradiated healthy tissue, than does the 400 kv. apparatus.—*Arno W. Sommer, M.D.*

Germann, Donald R. Teleroentgenographic pelvimetry; preliminary report. *Radiology*, April, 1952, *58*, 548–551.

Using a target-screen distance of 476 cm. and a therapy type roentgen tube operating at 180 kv. and 20 ma. (inherent h.v.l. 0.8 mm. Cu), teleroentgenographic pelvigrams are produced. A Camp Lysholm grid cassette is employed to reduce scatter, and times of five and fifteen seconds are used for the upright anteroposterior and lateral exposures respectively. At this distance, the magnification error is less than 5 per cent at an object-screen distance of 20 cm., hence direct measurement of all planes is possible.—*Martin B. Goodwin, M.D.*

Nielsen, Howard. Rotatory irradiation. *Acta radiol.*, March–April, 1952, *37*, 318–328.

When, in August, 1941, rotatory irradiation was introduced at the Radium Center, Aarhus, as a practical method of therapy, a number of difficulties with regard to dosage were at once encountered. For the purpose of creating a practical and useful basis for planning treatment, a number of measurement experiments were made during the years that followed.

From examinations of the dose in cylindrical (homogeneous) phantoms the following conclusions may be drawn:

1. Surface dose (*Do*) in relation to free air dose (*I*) at target-axis distance (50 cm.). Provided the height of the axis field remains constant, the surface dose is chiefly determined by the illumination time, *i.e.*, the width of the axis field, and is proportional to it. A change in the quality of the radiation in the range half-value layer 0.70–1.75 mm. Cu is of no importance. The surface dose follows the inverse square law.

2. Axis dose (*Dx/I*) (*i.e.*, dose at the rotation axis (*Dx*) in relation to free air dose at target-axis distance). This is measured in the rotation axis, and with changes of the physical factors, follows the same rules as the depth dose with fixed fields.

3. The percentage depth dose (*Dx/Do*). With narrow axis fields this is considerable and it can be increased by means of hard radiation, long target-axis distance and large rotation angle (360°).

4. The distribution of the radiation changes with the width of the axis field, the radius of the phantom, the quality of the rays and the target-axis distance. With fields not too wide, the distribution of the radiation is bell shaped with the maximum dose around the rotation axis (if it coincides with the axis of the phantom, and the rotation angle is 360°) and with an even or a more abrupt decline towards the surface. Under certain conditions (wide fields), the maximum dose can be found to form a ring around the axis. The representation of the three-dimensional dosage distribution in cylindrical phantoms is given and its peculiarities are pointed out. The dosage distribution with rotation angles of 90° to 180° and 270° is illustrated by isodose charts.

From these fundamental experiments in cylindrical phantoms, the dosage distribution was examined in all the regions of the body which differ essentially from the homogeneous cylindrical phantom. In this manner it was demonstrated that the body structure built up of media having different absorption factors for roentgen rays plays an important role in the dosage distribution and thus in the effectiveness of the irradiation.—*Mary Frances Vastine, M.D.*